BIOGAS COMBUSTION PLANT

MAINTENANCE MANUAL

(PLANT MAINTENANCE MANUAL)

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4.2.6 Equipment calibration procedure

4.2.6.1 Scope

This procedure defines the management, checks and calibration of the equipment used for process control.

4.2.6.2. Responsibility

PM will be responsible for the management of the pieces of equipment needing regular calibration for the biogas installations.

The regular check and calibration will be entrusted to the operators and/or the equipment supplier. The PM will be responsible for checking the equipment's proper working order, as well as check and store up the calibration certificates.

4.2.6.3. Operating modes

Fixed methane and oxygen analyzer

The biogas analyzer installed at the plant, which measures the concentration of methane and oxygen in the biogas, shall be systematically checked and calibrated.

The PM in charge of the plant shall, in collaboration with the local operator, keep the unit conditions and functioning under control, as well as carry out the calibration at least once a month and also make sure that certified, valid gas calibration cylinders will be used for calibration. Moreover, the PM shall verify that the piece of equipment will be properly identified and that the calibration expiry date will be clearly visible. In the event that anomalies are found in equipment operation, the PM may request further checks and additional calibrations (if any) to be carried out by the supplier.

The calibration gas shall be procured from certified gas suppliers. All the gas calibration cylinders shall be accompanied by a quality certificate.

The operators shall be qualified and aware of the calibration procedures.

The fixed analyzers can be calibrated either together or individually. In the following description, it is assumed that both pieces of equipment shall be calibrated simultaneously. Refer to the specific manual available at the plant for more details on the fixed equipment calibration operating modes.

Fixed methane analyzer: Siemens – ULTRAMAT 23

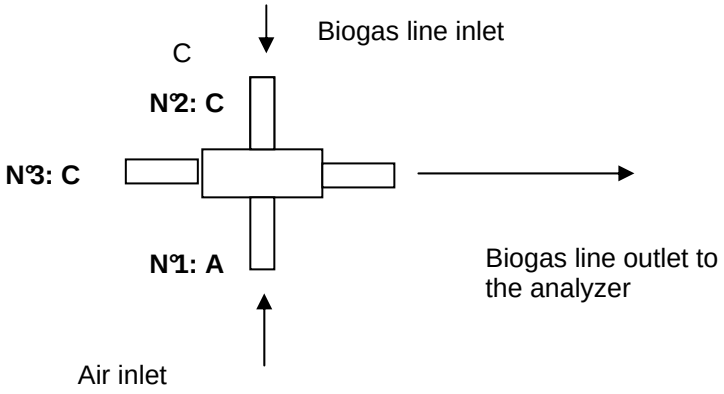
Fixed oxygen analyzer: Siemens – OXIMAT 61

The PM in charge of the plant shall, in collaboration with the local operator, keep the unit conditions and functioning under control, as well as carry out the calibration at least once a month and also make sure that certified, valid decanters will be used for calibration.

Below is a description of the operating procedure for manual equipment calibration.

To calibrate the Ultramat point 0 (zero) and the Oximat span (20.9% O2):

- Open valve 1 and close valve 2 (see diagram) indicated below within the analysis panel (A: open C: closed)



- This will allow atmospheric air to flow in for the calibration of the max. percentage of O2 (20.9%) and 0% methane (CH4).
- Then go to the Oxymat equipment and press the second button (not identified) found on the right of the screen.
- The following menu will be displayed:
    a. Diagnostic
    b. Adjustment
    c. Measurement margin
    d. Parameters
    e. Configuration

- Select “Adjustment” and enter the level 1 code (known only to the PM in charge): to do this, move the direction arrows up or down to change the value of the selected digit, and the right or left arrows to change the location. Then press ENTER.
- The following submenus will be displayed in the “Adjustment” menu:
    a. Point 0 adjustment
    b. Sensitivity adjustment
    c. Point 0/sensitivity nominal values
    d. Full/individual adjustment
    e. Self-calibration.

- To obtain the maximum O2 (i.e. minimum CH4), select the “Point 0 adjustment” menu and press ENTER: the equipment will measure a reference value in the top part (20.9) and another one which will be the value measured below the first one.
- Verify that the reference value is 20.9%; otherwise, proceed with item “c” (point 0/sensitivity nominal values) and set the point 0 value by adjusting the same to 20.9%.
- The second value will oscillate until it gets stable (note down such value on the module as the detected O2/air value of the Oximat module); if the value differs from 20.xx (set-point), press the MEAS button on the Oximat, then accept the value forced on the calibration by touching the corresponding value (note down such value on the module as the calibrated O2/air value of the Oximat module).
- Take note of the value read by the Ultramat (note down this value as the detected O2/air value of the Ultramat module).
- Press the Ultramat analyzer CAL key, then wait for the process to be completed (note down this as the calibrated O2/air value of the Ultramat module).

To calibrate the Ultramat span:

- Press the Ultramat “ENTER” key: you will access the main menu list:
    a. Diagnostic
    b. Adjustment
    c. Parameters
    d. Configuration

- Select “Adjustment” by moving around with the direction arrows, then press ENTER.
- The equipment will ask you to enter the level 1 code.
- Another menu with the options below will be displayed:
    a. MMIR adjustment
    b. Pressure sensor adjustment
    c. Self-calibration.

    - Select menu “a” and prepare the calibration decanter in order for the same to be connected when requested. The following will appear on the new screen (MM CH4 Adjustments):
        a. Nominal values: MM 1 + 2
        b. Full adjustment
        c. Enter self-calibration
        d. MM 1+2 : 60.2
        e. MM 1+2: 60.2

- The nominal value shall be changed in the preceding step, in the event that the MM 1+2 number differs from the calibration cylinder one. To do this, go to the corresponding line (a) and press

ENTER so as to access the number sector, then change the number by means of the direction arrows. Finally, press ENTER again.

- After the preceding step is completed, a new screen will appear, which will display the following:
    a. MM 1 + 2 M1 adjustment start
    b. MM 1 + 2 M2 adjustment start.

- Select option “a”, then press ENTER. The following will appear on the screen:
    Nominal value adjustment – 60.2
    Actual value adjustment (value recorded by the equipment)
    Enter gas pattern.
- Now connect the analysis decanter sleeve to valve 3 shown in the diagram illustrated above.
- The equipment will start measuring the gas pattern; when the same has stabilized (note down this value as the detected CH4 value 60.2% of the Ultramat module), press ENTER to accept the measured value (note down this value as the calibrated CH4 value 60.2% of the Ultramat module).
- Press ESC, then press MEAS to record the changes; next, select “YES” and press ENTER again.

The methane Maximum calibration will now be concluded.

To calibrate the O2 minimum, go to the OXIMAT equipment and proceed as follows.

- Press the second button (not identified) found on the right of the screen.
- The following menu will be displayed:
    a. Diagnostic
    b. Adjustment
    c. Measurement margin
    d. Parameters
    e. Configuration.

- Select “Adjustment” and enter the level 1 code, as described above.
- The following submenus will be displayed in the “Adjustment” menu:
    a. Point 0 adjustment
    b. Sensitivity adjustment
    c. Point 0/sensitivity nominal values
    d. Full/individual adjustment
    e. Self-calibration.

- To obtain the O2 minimum (0%), select the “Sensitivity adjustment” menu and press ENTER: the equipment will measure a reference value in the top part (0.00) and another one which will be the value measured below the first one. If the higher value is different from 0, it shall be modified: to do this, go to the corresponding line (b) and press ENTER so as to access the number sector, then change the number by means of the direction arrows. Finally, press ENTER again.

- The lower value will oscillate until it gets stable (note down such value as the detected O2 0% value of the Oximat module); if the value differs from 0.00 (set-point), press the MEAS button on the Oximat, then accept the value forced on the calibration (note down such value as the calibrated O2 0% value of the Oximat module).

The operator shall complete the analyzer calibration form MCTR008.

Innova methane and oxygen portable analyzer

The PM in charge of the plant shall, in collaboration with the local operator, keep the unit conditions and functioning under control, as well as carry out the calibration at least once a month and also make sure that certified, valid decanters will be used for calibration.

In the event that anomalies are found in equipment operation, the PM may request further checks and additional calibrations (if any) to be carried out by the supplier.

Below is a description of the operating procedure for CH4 %V manual calibration.

- Switch the equipment on, then wait for the warm-up phase to end.
- Press the ↑ and ↓ buttons together for 3 seconds, until the "**Menu features**" message disappears.
- When the "**Begin CAL**" message is displayed on the screen, press → to accept.
- Shift from "**Auto CAL**", by pressing ↑ or ↓, to "**Manual CAL**", then accept by pressing →.
- CH4 will be displayed in the top right corner of the screen, referring to the selected sensor. Change by pressing → until the letters "**TC**" are displayed in the left bottom part. This corresponds to the methane sensor for the % value.
- Having accepted the TC calibration, you will have to correct the sensor setting to 60 (by means of the ↑ or ↓ buttons) and then accept by pressing →.
- Start the calibration procedure, by first leaving the decanter disconnected and then coupling the same when it reads "**Apply gas**". Wait the necessary time: the "**Calibration OK**" message will be displayed. Accept by pressing → and take note of the changes.

To calibrate the O2 sensor, proceed as follows:

- Press the ↑ and ↓ buttons together for 3 seconds, until the "**Menu features**" message disappears.
- When the "**Begin CAL**" message is displayed on the screen, press ↑ or ↓ to go to "**Advanced Features**".
- Enter by pressing → and then press ↑ or ↓ until "**Sensor Select**" is displayed. Enter by pressing →.
- "CH4 O2" (at the top) and "OFF OFF" (at the bottom) will be displayed on the screen, from right to left. To deactivate CH$ (OFF), press ↑ or ↓; to go to a different location, press → until you leave the "**Sensor Select**" menu, press ↑ or ↓ until **Exit** is displayed, press →.

- Press the ↑ and ↓ buttons together for 3 seconds, until the "**Menu features**" message disappears.
- When the "**Begin CAL**" message is displayed on the screen, press → to accept.
- Shift from "**Auto CAL**", by pressing ↑ or ↓, to "**Manual CAL**", then accept by pressing →.
- After accepting, you will be asked to adjust the sensor calibration value by means of the ↑ or ↓ buttons (you will set 0%). Once the correct number has been entered, press → to continue.
- The analyzer will request that N2 shall be connected to calibrate the equipment zero (0): you will set the calibration decanter.
- Wait until the process is ended, then accept by pressing →. If the calibration has been concluded successfully, start again without selecting "Abort".

Refer to the manual for more details.

The operator shall complete the analyzer calibration form MCTR008.

Flow meter

The Rosemount 285 Annubar flow meters installed on the torch line and the motor line require calibration to be carried out once a year.

The two meters can be calibrated by making use of the portable, differential switch MAGNEHELIC CAT n° 2000-50 (available at the plant) as well as the pipes needed for its connection.

Each of the two flow meters is connected with an ABB pressure transmitter (series 2600T) on which the calibration operations will be carried out. The calculation sheets indicating the calibration values are included in the technical documents of the Rosemount meter, available at the plant.

Calibration procedure for the ABB pressure transmitter (series 2600T):

- Verify, by means of the portable pressure meter, that the value detected on the torch pressure line corresponds to the value indicated in the software.
- If the pressure indicated on the meter display exceeds by +/- 2% the pressure measured by the transmitter on the PC monitor, the same shall be replaced with a new transmitter.
- The out-of-calibration transmitter shall be forwarded to a specialized service centre in order to be calibrated (manufacturer).

The operator shall complete the "Flow meter calibration form MCTR012".

Calibration procedure for the Rosemount 285 Annubar flow meters installed on the torch line and the motor line:

- Undo one of the two screws of the meter identification plate: by rotating the plate, you can access the two calibration buttons identified by letters Z and S.

- Disconnect the plastic pipes that connect the ABB meter with the Rosemount 285 Annubar.
- Now you can press the “Z” button to calibrate the instrument zero, by verifying that the volume displayed on the supervision system is equal to 0.
- Connect the differential pressure meter plastic pipe with the pressure transmitter “HIGH” input, then fix, by blowing into the pressure meter feed plastic pipe and closing the meter shut-off valve, the desired pressure value (155.97 mmH_2O for the torch line flow meter; 231.56 mmH_2O for the future motor line). Once you have certified that the fixed value is correct, press the “S” button to calibrate the meter span.
- Before disconnecting the pressure meter, verify that the volume displayed on the supervision system is equal to 2,000 Nm^3/h (torch line) or 200 Nm^3/h (motor line), depending on the meter that has been calibrated.
- Disconnect the pressure meter, close the transmitter plate and reconnect the plastic pipes running from the Rosemount, taking care that the pipe running from the line corresponds to the “High” inlet.

The operator shall complete the “Flow meter calibration form MCTR012”.

Procedure for checking the calibration of the ELSI temperature sensor (“S” and “PT100” types).

The thermocouples cannot be calibrated in the plant, but only through special equipment, by specialized service centres or the manufacturer themselves. For this reason, the description below refers to the control procedure needed to calibrate the sensor by means of the HDT-18833 infrared pyrometer.

- Insert the measuring probe in direct contact with the gas flow to be measured in the lower part of the thermometer.
- Insert the probe inside the measuring point fitted on the torch biogas inlet line near the thermocouple installed for continuous temperature control.
- If the temperature shown on the meter display exceeds by +/- 1.5% the temperature measured by the thermocouple and read on the PC monitor, the same shall be replaced with a new thermocouple.
- The out-of-calibration thermocouple shall be forwarded to a specialized service centre in order to be calibrated (manufacturer).
- The infrared thermometer shall be calibrated at a specialized centre (manufacturer) on an annual basis, and the calibration certificates shall be kept and made available at the plant.

The operator shall complete the “Flow meter calibration form MCTR012”.