40 75 21.13 – Process Liquid Analytical Measurement (Free-Chlorine Analysers)

COMBINED AMPEROMETRIC/COLORIMETRIC FREE CHLORINE ANALYSER

PART 1- GENERAL

SUMMARY

A programmable Free Chlorine Controller/Analyser System shall be supplied for continuous monitoring and/or control of free chlorine in water.

AMPEROMETRIC FREE CHLORINE ANALYSER

1. **Controller/Analyser Requirements**

The controller/analyser shall:

a. Provide continuous, real-time monitoring and control of free residual chlorine.

b. Incorporate both amperometric and colorimetric technologies for the measurement of chlorine into one device.

c. Be capable of automatic calibration if the amperometric section of the device, via the colorimetric section of the same device.

d. Have capability to control the dosing of free chlorine, including flow-adjusted dosing.

e. Allow the setup of multiple password-enabled user logins, with access logs available. Logins will have configurable levels of access to system settings.

f. Provide viewable and downloadable data logs, status logs and service reports.

g. Provide options for the communication of data, statuses and errors to local SCADA systems (or similar).

2. **Standards and Certifications**

a. The manufacturer shall provide a controller enclosure rated to IP65/NEMA 4X. Any accompanying enclosures, e.g. for the purpose of expanding the capacity of the controller, shall also be rated to IP65/NEMA 4X.

b. The controller system shall be manufactured in accordance with ISO 9001:2015, in an externally audited quality management system.

SYSTEM FEATURES

1. Control Feature Requirements

The controller will be capable of (either by default or optionally):

a. Providing dosing outputs in the following operator selectable modes: off, manual, automatic

b. Dosing via PID (Proportional/Integral/Derivative) algorithms. The controller will be able to provide a percentage output to chemical feed pumps for true PID control via 4-20mA signal and/or relay (digital output) in on/off, pulse width or pulse frequency modes

c. PID control which will have the following options and/or safety features:

   i. Dedicated failure mode, where dosing can be set to ‘off’ or a pre-defined percentage value in the event of an error state
   ii. Be capable of accepting a site stop signal to cease dosing
   iii. Be able to limit dosing % output to defined minimum and maximum values
   iv. Configurable overfeed protection, in the event of a failure of dosing hardware (e.g. blocked injectors, empty chemical tanks and the like)
   v. Viewable PID diagnostic screen, illustrating the extent to which the elements of the algorithm (proportional/integral/derivative) are contributing to the total percentage output

d. Responding to the loss of sample flow (detected via the flow cell assembly flow switch) by entering an alarm state and switching active PID dosing to off/a set manual % value

e. Programmable events can be set via timer (e.g. every 24 hours) or scheduler (e.g. day/week/month)

f. Providing viewable and downloadable data logs, status logs and service reports on controller operations

2. Hardware Requirements

The controller shall be supplied with:

a. A free chlorine monitor, incorporating both amperometric and colorimetric elements.

b. A suitable flow switch for the detection of sufficient sample water flow.

c. Suitable level switches for the detection of low chemical levels.

Additionally, the following options/upgrades must be made available:

a. Additional and/or replacement sensors (including, but not limited to):

   i. Total chlorine
   ii. pH
   iii. ORP/Redox
   iv. Conductivity
   v. Alkalinity
   vi. Turbidity

b. Digital outputs (relays) up to a maximum of 8 per enclosure
c. Digital inputs up to a maximum of 8 per enclosure
d. Analogue outputs (4-20mA) up to a maximum of 4 per enclosure
e. A backboard incorporating both controller/analyser and free chlorine monitor

The system should also be expandable, by the addition of extra enclosures (or similar) to increase the capacity of an individual system beyond the limits stated above.

3. Communication Requirements

In addition to the outputs stated above, the controller shall have the followings features available either by default or optionally:

a. Digital industrial protocols, including; Modbus RS485, Modbus TCP/IP, Profibus DPV

b. LAN Ethernet or GPRS connectivity, providing access to an MQTT server system that allows two-way remote communication with the controller/analyser. This communication should include the ability to remotely alter systems settings and download service/access logs, although this feature should be limited by the security/access requirements below.

c. The controller shall be accessible with a standard Internet browser using a fully interactive graphical interface that can include multiple accounts of varying security and access levels. The controller shall be capable of providing real-time monitoring and control via a personal computer, smartphone, or tablet device. Controllers that require software or apps for communications shall not be considered equal.

d. The controller shall be capable of e-mail and SMS text alerts upon alarm activation. Controllers without the option of email and text notifications shall not be considered equal.

e. Online data logging/storage for 30 days or more, with this data being made available for download (in an easily accessible, non-proprietary file format) via Internet browser.

f. The controller shall include at least two programmable threshold levels and at least two programmable alarm levels for each sensor parameter. Both audible and visible alarms should be provided with the controller/analyser.

PART 2- PRODUCTS

SENSORS

1. Sensor Requirements

The system for the monitoring of free chlorine levels shall utilize two sensor technologies:

Amperometric

a. A membrane covered potentiostatic 3-electrode system, with a specially placed counter electrode. The gold working electrode is membrane covered and is in the electrolyte area together with the reference electrode. This electrolyte area contains a special electrolyte which is separated from the sample water. During operation, chlorine diffuses out of the sample water, through the membrane and, with the help of the electrolyte, causes an electrical signal at the working electrode. The electrical signal at the working electrode is proportional to the chlorine concentration and is amplified by the electronics in the sensor.

b. Internal temperature compensation (e.g. via an integrated temperature sensor), ensuring independence of chlorine level and sample water temperature.

Colorimetric

a. A method of colorimetric analysis that is not affected by changes in sample pH.

b. Although optional, does not require calibration in situ.

c. Is capable of performing a colorimetric test every 2.5 minutes.

d. Uses an LED emitter with a peak wavelength of 515nm.

e. Performs a blank ‘zero’ measurement prior to each colorimetric test, to account for changes in turbidity, colour etc.

f. Can operated continually for 3-6 months without operator intervention.

g. Is capable of displaying reagent levels on the screen of the controller/analyser.

h. Has maintenance notifications including reagent replacement and tubing replacement.

Combined Technology Features

a. Upon initial startup, accounts for polarisation time of amperometric technology by operating the DPD element as the primary form of chlorine measurement , with colorimetric tests performed every 2.5 minutes.

b. After a monitoring period to determine stability of the amperometric element, perform a colorimetric test to calibrate this element allowing it to become the primary form of chlorine measurement.

c. While amperometry is the primary form of measurement, increase the interval between colorimetric tests to reduce chemical usage e.g from 2.5 minutes to 1 hour.

d. Periodically compare the chlorine levels reported by the amperometric and colorimetric elements, to ensure accuracy and stability of the amperometric element.

e. When required (as defined by user-determined settings), recalibrate the amperometric element (via the colorimetric element) automatically and without operator intervention.

f. If the amperometric element cannot be successfully calibrated (e.g. due to damage or hardware failure), allow the colorimetric element to resume as the primary measurement, until such time as the amperometric element can be brought back into service.

Sensor Specifications

a. **Amperometric Free Chlorine:**
   Range: 0-5 mg/l
   Limit of detection: 0.05 mg/l or less
   Resolution: 0.01 mg/l or better
   T_{90}: 120 seconds or less
   Slope drift: approx. -1% or less per month

b. **Free Chlorine:**
   Range: 0-5 mg/l
   Sample frequency: 2.5 – 100 minutes
   Limit of detection: 0.03 mg/l
   Resolution: 0.01 mg/l
   Stability: approx. +/-1% or less per month
   Wavelength: 515nm
   Temperature range: 0-45°C
   pH range: pH 4-12
   Zero point adjustment: Not necessary
   Calibration: None

FLOW CELLS

Flow Cell Requirements

The flow cell assembly provided will:

a. Include an overflow weir for the removal of bubbles in the sample water

b. Be rated to a pressure of at least 3 bar (43.5 psi)

WARRANTY

The controller electronics and sensors shall be covered by a standard manufacturer warranty of at least one (1) year.

PART 3 EXECUTION

Preparation

The flow cell assembly shall be provided pre-mounted onto a backboard, to allow for easy installation onto a suitable wall

Storage temperature should be 0 to 60 degrees Celsius, with the exception of the DPD colorimetry chemicals (5 to 40 degrees Celsius).

Contractor will install the transmitter and sensors in strict accordance with the manufacturer’s instructions and recommendation, including:

a. Suitable continual electrical supply (100-240VAC, or 9-36VDC in the case of DC-specified systems)
b. Suitable continual flow of sample water (approx.. 500ml/min)