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|  | Standard Operating Procedure Easy Cl Titrator Operation Maintenance and Qualification | | SOP Number D-810 | Revision 0 |
| | | | Effective Date 07/25/23 | Page Page 1 of 14 |
| Written by/ Date Steph S 07/12/23 | | Reviewed by/ Date CJP 07-12-23 | | Approved by/ Date SS 07/12/23 |
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1.0 Purpose

This procedure provides guidelines for general use, maintenance, and performance qualification of the Mettler Toledo Easy Cl titrator.

2.0 Scope

This procedure applies to the Mettler Toledo Easy Cl titrator in the QC laboratory.

3.0 Responsibility

- 3.1 It is the responsibility of QC chemists to follow this procedure.
- 3.2 It is the responsibility of QC Laboratory Management to ensure that this procedure is being followed.
- 3.3 It is the responsibility of Metrology and/or Analytical Development to perform preventative maintenance and performance qualification of the Easy Cl titrator.
- 3.4 It is the responsibility of QC Laboratory Management and/or Analytical Development personnel to keep this procedure aligned with current practices.

4.0 Definitions

- 4.1 **QC** – Quality Control
- 4.2 **AD** – Analytical Development
- 4.3 **H₂O** – Deionized Water
- 4.4 **NaCl** – Sodium Chloride
- 4.5 **KNO₃** – Potassium Nitrate
- 4.6 **HNO₃** – Nitric Acid

4.7 **AgNO₃** – Silver Nitrate

4.8 **VEQP** – Volume of titrant consumed to reach the equivalence point

5.0 References

5.1 EasyPlus™ Titration Operating Instructions

5.2 USP <541> Titrimetry

5.3 D-603, SOP, Chemical Waste Disposal

5.4 General European OMCL Network (GEON) Quality Management Document, PA/PH/OMCL (07) 108 R11, Qualification of Equipment Annex 5: Qualification of Automatic Titrators.

5.5 PRTCL-23-0049, Protocol, Installation Qualification and Operational Qualification of the Mettler Toledo Easy Cl Titrator

5.6 RPT-23-0040, Report, Installation Qualification and Operational Qualification of the Mettler Toledo Easy Cl Titrator

6.0 Safety Precautions

6.1 AgNO₃ solution may cause skin and/or eye irritation. Personal protective equipment including gloves and eye protection is recommended.

7.0 Waste Handling and Disposal

7.1 AgNO₃ solution is toxic to aquatic life. Store AgNO₃ waste separate from other waste streams. Waste handling and disposal procedures are outlined in SOP D-603.

8.0 Silver Ring Sensor

8.1 The Easy Cl titrator should be used with an EM45-BNC Silver Ring Sensor (Mettler Toledo Part # 30043107 or equivalent).

8.1.1 The sensor should be filled to approximately 1 cm below the fill opening with 0.1 N KNO₃ filling solution.

- 8.1.2 Before use, remove the plug from the fill opening.
- 8.1.3 The electrolyte solution inside of the sensor should always be above the level of the sample solution to keep the sample solution from entering the sensor.
- 8.1.4 To store the sensor: fill the storing cup about half way with 0.1 N KNO₃ filling solution, place the storing cup on the sensor ensuring that the tip of the sensor is submerged in filling solution, then close the filling plug. **Do not allow the tip of the sensor to dry out!**
- 8.1.5 If the electrode dries out, immerse the tip in H₂O for at least 15 min to dissolve any KNO₃ crystals that may have precipitated in or on the frit.

9.0 Reagents

- 9.1 Sodium chloride traceable reference standard
- 9.2 0.1 M AgNO₃ Titrant
 - 9.2.1 Silver nitrate is sensitive to light and air. Store protected from light in a tightly closed container.
 - 9.2.2 Use commercially prepared titrant, or prepare as outlined below.
 - 9.2.2.1 Accurately weigh and transfer 16.987 g of AgNO₃ into a 1000-mL low-actinic (red) or foil wrapped volumetric flask.
 - 9.2.2.2 Dissolve in and dilute to volume using H₂O.
- 9.3 2 M HNO₃
 - 9.3.1 Transfer 175 mL of H₂O to a 250-mL plastic bottle.
 - 9.3.2 Carefully add 25 mL of concentrated (~70%) HNO₃.
 - 9.3.3 Mix well.
- 9.4 1 M KNO₃ filling solution.
 - 9.4.1 Use commercially prepared filling solution, or prepare as outlined below.
 - 9.4.2 Accurately weigh and transfer about 10.1 g of KNO₃ into a suitable container.


9.4.3 Add 100 mL H₂O.

9.4.4 Mix to dissolve.

10.0 Rinsing the Burette

10.1 The burette should be rinsed with fresh titrant daily before first use.

10.2 Turn on by pressing the power button on front of the instrument. The instrument is ready when the status LED stops blinking.

10.3 The following icons are displayed on the main menu: Titration, Burette, Stirrer, Titrant, Sensor, and Measure. To reach home from another screen, select Home .

10.4 From the home screen, select Burette > Properties.

10.5 Ensure that the 20 mL burette is selected.

10.6 Place a waste collection vessel at the end of the titration tube.

10.7 Select Actions > Rinse > 1 cycle, and click the green start button.

10.8 Wait for the burette rinse to complete.

10.9 Check for air in the burette and tubing. If air remains in the burette and/or tubing, repeat the burette rinse.

10.10 After all air has been evacuated, remove the waste collection vessel.

11.0 Perform a Titer Determination

11.1 A titer determination should be performed every seven days.


11.2 From the home screen, select Titrant > Properties.

11.3 Ensure the following settings are correct:


11.3.1 Titrant = AgNO₃

11.3.2 Nominal concentration = 0.1 mol/L

11.4 Select Determination.


- 11.5 Ensure the following settings are correct:
- 11.5.1 Relevant EQP = 1
 - 11.5.2 Stir speed = Medium
 - 11.5.3 Predispense = 0 mL
 - 11.5.4 Control = Normal
 - 11.5.5 Prestir duration = 60 sec
 - 11.5.6 Wait time = 0 sec
 - 11.5.7 Primary Standard = NaCl
 - 11.5.8 Purity = (enter the reference standard purity in units of percent)
 - 11.5.9 Sample size entry = Variable
 - 11.5.10 Equivalence number = 1
 - 11.5.11 Multiple determination = Yes.
 - 11.5.12 Printout = Long
 - 11.5.13 Export = None
- 11.6 Weigh about 60 mg of sodium chloride reference standard directly into a titration vessel.
- 11.7 Add 50 mL H₂O.
- 11.8 Add 1.0 mL of 2 M HNO₃.
- 11.9 Add a stir bar.
- 11.10 Place the titration vessel on the stirrer, and lower the sensor and titration tube into the standard solution.
- 11.11 Begin the titer determination by pressing Start .
- 11.12 After the titer determination has been completed, the results will be printed.
- 11.13 Remove the titration vessel from the stand.

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- 11.14 Rinse the sensor and titration tube thoroughly with H₂O.
- 11.15 Repeat steps 11.8 – 11.16 for a total of three titer determinations.
- 11.16 After three titer determinations have been complete, select  to end.
- 11.17 The titer statistics will print, and the new titer value will be automatically saved.
- 11.18 Acceptance criteria = NMT 1.0% RSD.

12.0 Performing a Sample Determination

- 12.1 On the main screen, select Titration and verify that the following parameters are chosen:
 - 12.1.1 Relevant EQP = 1
 - 12.1.2 Titration type = Direct
 - 12.1.3 Control = Normal
 - 12.1.4 Sample ID = Variable
 - 12.1.5 Stir speed = Medium
 - 12.1.6 Pre-stir duration = 300 sec (longer time may be required for some samples)
 - 12.1.7 Pre-dispense = 0 mL
 - 12.1.8 Wait time = 0 sec
 - 12.1.9 Sample size entry = Variable weight
 - 12.1.10 Calculation = Content (mg/g or % depending on sample specification)
 - 12.1.11 Molecular weight = 35.453
 - 12.1.12 Equivalence number = 1
 - 12.1.13 Multiple determination = No
 - 12.1.14 Printout = Long
 - 12.1.15 Export = None
- 12.2 Place a stir bar into a titration vessel.

- 12.3 Weigh an amount of sample containing 15 - 64 mg of chloride into the titration vessel. This should result in a volume of titrant delivered (VEQP) during titration between 4 mL and 20 mL.
- 12.3.1 If the VEQP for the titration is less than 4 mL, then a larger sample size must be used.
- 12.3.2 If the VEQP for the titration is greater than 20 mL, then a smaller sample size must be used.
- 12.4 Add 50 mL of H₂O.
- 12.5 Add 1.0 mL of 2 M HNO₃.
- 12.6 Place the titration vessel on the stirrer, and lower the sensor and titration tube into the sample solution.
- 12.7 Begin the sample determination by pressing Start .
- 12.8 Follow the progress of the titration on the screen.
- 12.9 After the determination is complete, a report will be printed.
- 12.10 Remove the titration vessel from the stand.
- 12.11 Rinse the sensor and titration tube thoroughly with H₂O.

13.0 Daily Cleaning

- 13.1 Thoroughly rinse the sensor (probe) and titration tube with water. Use a moist tissue to remove any remaining residue.
- 13.2 To store the sensor: Fill the storing cup about half way with 0.1 N KNO₃ filling solution. Ensure that the filling plug is open. Place the filling cup on the sensor ensuring that the tip of the sensor is submerged in filling solution, and close the filling plug. **Do not allow the tip of the sensor to dry out!**
- 13.3 Clean the instrument housing using a tissue moistened with H₂O or mild detergent solution.

14.0 Preventative Maintenance

- 14.1 Preventative maintenance should be performed every six months.
- 14.2 Clean the instrument housing using a tissue moistened with H₂O or a mild detergent solution.
- 14.3 Rinse tubes, valve, and burette.
 - 14.3.1 Remove the green tube from the beaker and place it in a waste container.
 - 14.3.2 Unscrew the blue tube from the bottle and place it in an empty container.
 - 14.3.3 To empty the tubes, run the function Burette > Rinse until all tubes are empty.
 - 14.3.4 Place the blue tube in a bottle with H₂O.
 - 14.3.5 Run the function Burette > Rinse until the tubes are rinsed.
 - 14.3.6 Place the blue tube in a bottle with ethanol.
 - 14.3.7 Run the function Burette > Rinse until the tubes are rinsed.
 - 14.3.8 Place the blue tube in an empty bottle.
 - 14.3.9 Run the function Burette > Rinse until the tubes are empty.

14.4 Disassemble the burette.

14.4.1 **Do not pull the piston out of the glass cylinder!
Reinserting the piston into the glass cylinder will
damage the o-rings.**

14.4.2 Rinse and empty the burette, valve and tubes as outline
above.

14.4.3 Disconnect the instrument from the power supply.

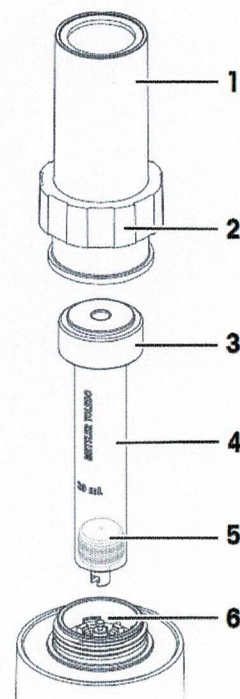
14.4.4 Disconnect the red tube from the top of the burette cap
(3) and clean the connections with a tissue.

14.4.5 Disconnect the cap nut (2).

14.4.6 Lift off the burette cover (1) including the cap nut (2).

14.4.7 Carefully lift the glass cylinder (4), until you are able
to slide the burette from the piston rod (6).

14.4.8 Remove the burette cap (3) and empty the burette into
a waste bottle.



14.4.9 Replace the burette if the piston leaks, if the glass cylinder is badly scored at the edge, or if crystals have formed between the seals of the piston.

14.5 Clean the burette parts.

14.5.1 **Never place O-rings in organic solvents.**

14.5.2 **Never attempt to remove any crystals in the cylinder by scratching with a hard object.**

14.5.3 **Never put the parts in a drying oven with a temperature higher than 40°C.**

14.5.4 Rinse cylinder, valve, and tubes first with H₂O and then with ethanol.

14.5.5 Dry the parts with oil-free compressed air or nitrogen.

14.6 Clean the burette compartment

14.6.1 Disconnect the instrument from the power supply.

14.6.2 If there is liquid in the burette compartment, absorb the liquid with a cotton swab or tissue.

14.6.3 Push a thin rod from the rear of the instrument (2) into the outlet (1) of the burette compartment.

14.6.4 Pull the thin rod out of the outlet.

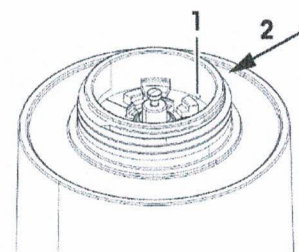
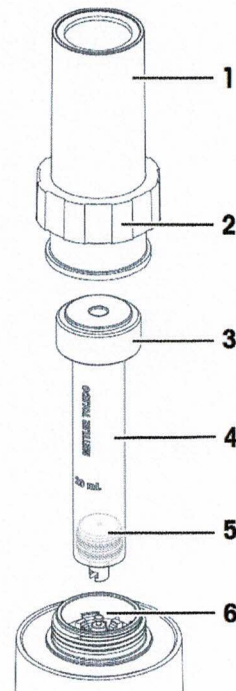
14.6.5 If the thin rod has pushed dirt into the valve compartment, take the dirt out with tweezers.

14.7 Assemble the burette

14.7.1 Disconnect the instrument from the power supply.

14.7.2 Place the burette cap (3) onto the glass cylinder (4).

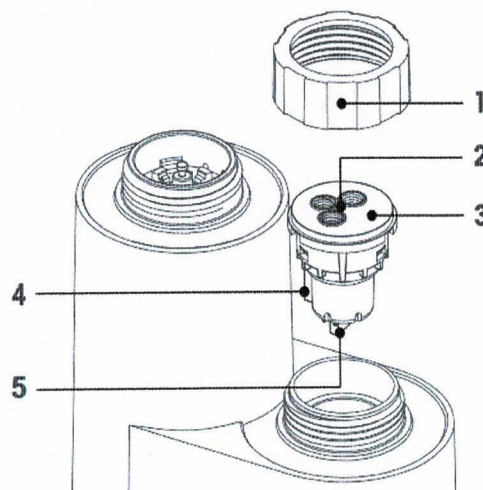
14.7.3 Slide the glass cylinder (4) onto the piston rod (6).



- 14.7.4 Carefully press the glass cylinder (4) down until it touches the housing of the instrument.
- 14.7.5 Place the burette cover (1) over the glass cylinder.
- 14.7.6 Place the cap nut (2) over the burette cover (1).
- 14.7.7 Screw the cap nut (2) onto the housing of the instrument and tighten it.
- 14.7.8 Screw one of the connectors of the red tube into the burette cap (3) and tighten it.
- 14.7.9 Screw the other connector of the red tube into the red opening of the valve and tighten it.
- 14.7.10 Make sure that all tubes are firmly connected and all cap nuts tightened.

14.8 Remove the valve.

- 14.8.1 The burette, valve and tubes should be rinsed and emptied as outlined above prior to removing the valve.
- 14.8.2 Disconnect the instrument from the power supply.
- 14.8.3 Unscrew all tube connectors (2) from the valve and clean the tube connectors with a tissue.
- 14.8.4 Check that all tube connectors are removed.
- 14.8.5 Unscrew the cap nut (1) holding the valve.
- 14.8.6 Remove the valve (3).



14.9 Clean the valve.

14.9.1 Place the valve for 30 minutes, or until the residue is dissolved, in deionized water or in ethanol.

14.9.2 Take the valve out and leave it to air-dry.

14.10 Clean out the valve compartment.

14.10.1 The valve should be removed as described above prior to cleaning the valve compartment.

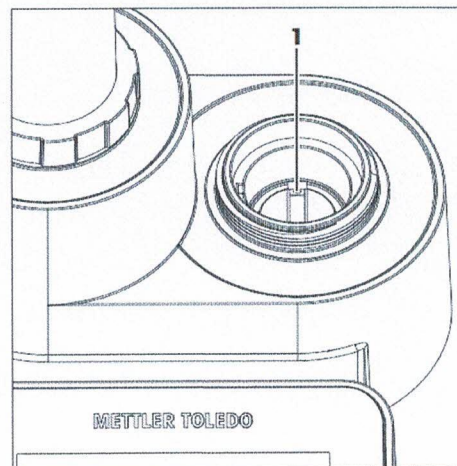
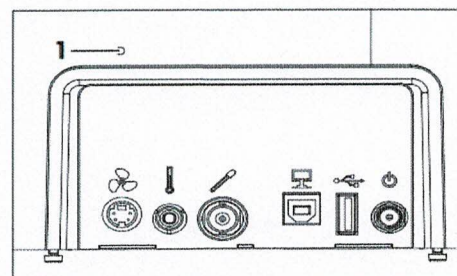
14.10.2 Disconnect the instrument from the power supply.

14.10.3 If there is liquid in the valve compartment, absorb the liquid with a swab or tissue.

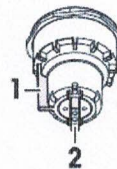
14.10.4 Push a thin rod from the rear of the instrument into the outlet (1) of the valve compartment.

14.10.5 Check that the end of the thin rod reaches the opening of the outlet (1) in the valve compartment.

14.10.6 Pull the thin rod out of the outlet.



14.10.7 If the thin rod has pushed dirt into the valve compartment, take the dirt out with tweezers.



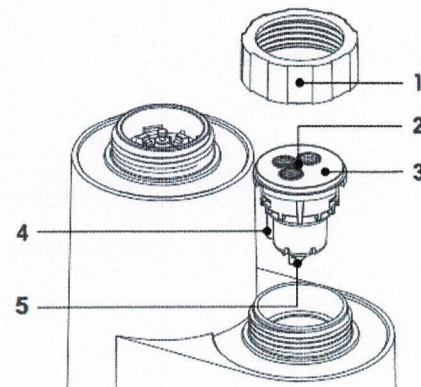
14.11 Install the valve.

14.11.1 Make sure that the guide (1) is perpendicular to the driver bar (2).

14.11.2 Orient the valve so the guide (4) points toward the burette.

14.11.3 Insert the valve (3).

14.11.4 Screw the cap nut (1) on the instrument and tighten it.



14.12 Replace the siphon tip.

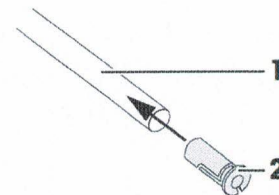
14.12.1 Place a waste bottle next to the instrument.

14.12.2 Pull the green tube from the beaker and place it in a waste container.

14.12.3 Unscrew the green tube from the valve and empty the tube into the waste container.

14.12.4 Pull the siphon tip (2) with tweezers out of the tip of the green tube (1).

14.12.5 Push a new siphon tip (2) into the tip of the green tube (1).



15.0 Performance Qualification

15.1 Performance Qualification shall be performed annually.

15.2 Prior to performance qualification, perform all preventative maintenance outlined above.

15.3 Performance qualification shall be performed using a freshly opened bottle of commercial titrant.

15.4 Precision

15.5 Perform 5 titer determinations using about 25 mg, 45 mg, 65 mg, 85 mg, and 105 mg of sodium chloride reference standard for the 5 determinations.

15.5.1 The instrument will print a summary including the mean titer and %RSD for the replicate determinations.

15.5.2 Acceptance Criteria: NMT 1.0 % RSD.

15.6 Linearity

15.6.1 Using the data obtained for evaluation of Precision, create a plot of mL titrant delivered vs. reference standard weight.

15.6.2 Determine a linear regression using the method of least-squares.

15.6.3 Acceptance criteria: R² is NLT 0.998.

15.7 Accuracy

15.7.1 Using the data obtained for evaluation of Precision, calculate the average (mean) titer value.

15.7.2 Calculate the Accuracy:

$$Accuracy (\%) = \frac{titer_{mean}}{titer_{theoretical}} \times 100$$

15.7.3 Acceptance Criteria: 99% - 101%

16.0 Consumables List

16.1 Beakers 100mL polypropylene (120 pcs.) Mettler Toledo Part # 51109388 or equivalent.

16.2 Sensor EM45-BNC Mettler Toledo Part # 30043107.

16.3 Siphon Tips (5 pcs.) Mettler Toledo Part # 23240.

17.0 Revision History

| Revision | Date | Description of Changes | CCR # | By |
|----------|----------|------------------------|-------|------------|
| 0 | 07/12/23 | New | N/A | S. Sassman |