

OPERATIONS MANUAL

Models: LCA-1, LCA-2, LCA-3



Laboratory Charge Analyzer

Revised 05/01/2017



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1. Product Description

1.1 General

The Laboratory Charge Analyzer (LCA) is used to determine the charge demand (aka coagulant demand) of an aqueous sample like raw water coming into a water treatment plant. The LCA performs a titration of the sample using coagulants (or polymers) until the sample's charge is neutralized. The LCA provides a real-time measurement of charge neutralization using streaming current technology. Streaming current is a term which is commonly interchanged with “charge” or “charge measurement.” Streaming current is a very small current that is generated by the mechanical separation, or shearing, of ions from the diffuse layer that surrounds charged species like macromolecules and colloidal particles (Figure 1).

A streaming current device (Figure 2) is easily identified by its reciprocating plastic piston that travels inside the annulus of a plastic probe fitted with two electrodes. The movement of the piston displaces the liquid in the annulus, forcing the liquid to travel rapidly across the piston surfaces. Soluble and colloidal charged species in the sample momentarily attached to the reciprocating piston via Van Der Waals attraction forces, and the rapid fluid motion across the piston surface, causes loosely bound counter-ions to be sheared away from the charged species attached to the cylinder walls. Electrodes in the cylinder measure this tiny current generated by the sheared counter-ions. The signal is electronically processed and the resulting readout is called the streaming current value (SCV), which can be thought of as a mV value, but actual correlation to a true mV value is not possible unless the instrument is specially calibrated using zeta potential measurement.

The SCV is sometimes referred to as “Particle Charge” or “Ionic Charge” measurement by other manufacturers.

The LCA-3 is unique among lab charge analyzers in that it can control the pH during the charge titration and this allows the LCA to more accurately determine the optimum coagulant dosage (versus those units which cannot control pH). Sample pH is especially important when working with inorganic coagulants and pH must be taken into consideration when performing

titrations in order to obtain accurate charge demand analysis results.

Higher alkalinity samples may require the pH to first be lowered with additions of Acetic in order to ensure the aluminum species are in the correct form for charge analysis (this is akin to chlorine measurements where the sample pH is buffered to improve measurement accuracy). Lower alkalinity samples will possibly require the addition of a base (e.g., sodium hydroxide). This manual attempts to cover the most important aspects of the laboratory charge analysis testing procedures, but it is very important to realize that several factors will impact the measurement result. It is highly recommend to consult with Chemtrac’s application experts to ensure the test procedure is optimized for plant conditions.

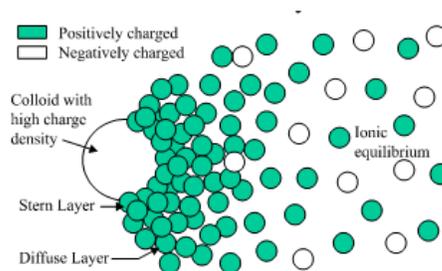


Figure 1 - Double Layer Charge

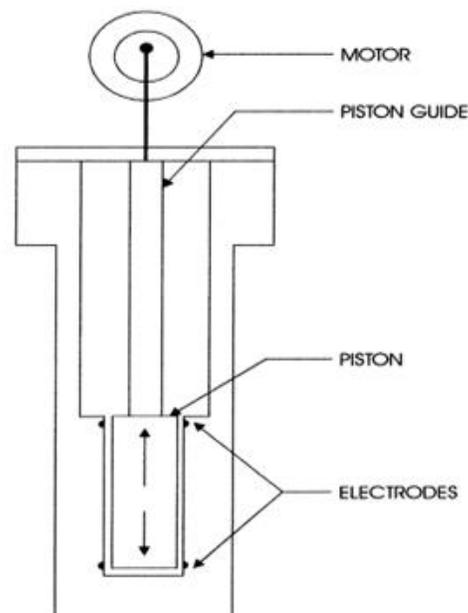


Figure 2 - Streaming Current Sensor

1.2 Applications

1.2.1 Determining Coagulant Dosage

In water treatment applications, the LCA provides a fast and simple method of determining the optimum coagulant or polymer dosage needed for maximum removal of turbidity (NTU) and organics (NOM/TOC).

1.2.2 Determining Caustic Dosage

The LCA-3 with its automatic pH titration can be used to determine how much base (e.g. caustic, lime) is needed along with coagulant to achieve optimum pH conditions for coagulation.

1.2.3 Determining Polymer Dosage

In wastewater applications, the LCA can potentially be used to help optimize polymer dosage for clarification and dewatering. Measurements of centrifuge centrate, or gravity belt thickener or belt filter press filtrate, can be made to see where charge is running, and confirm proper dosing.

1.2.4 Charge Demand

In Pulp & Paper applications, the LCA is used to determine the cationic or anionic charge demand of a sample which helps quantify swings in charge that can occur on the paper machine.

Charge demand is determined by titrating a sample with a polymer of opposite charge (typically DADMAC or PVSK).

1.2.5 Determination of Isoelectric Point

The LCA can be used to find the Isoelectric Point (IEP) of dispersions using an Acid or Base titration. The IEP is the pH at which a particular molecule or particle carries no net electrical charge.

If the sample is cationic, the sample is titrated with a base until the SCV value reaches 0 (or neutral). If the sample is anionic, an acid is used instead.

1.2.6 Other Applications

The LCA can be used in a variety of other applications where soluble/colloidal charge is of concern.

1.3 Model Designation

The LCA comes in three models which are identified as LCA-1, LCA-2, and LCA-3. The model number is located on the instruments identification label, which is found on the back of the device.

LCA-1 has no internal titration pumps, requiring all titrations to be performed manually.

LCA-2 has one internal pump for titrating the sample with a coagulant or polymer.

LCA-3 has two internal titration pumps. One pump is for titrating the sample with a coagulant or polymer. The second pump can be used for titrating the sample with an acid or base; or used with an anionic polymer when doing charge demand titrations. The LCA-3 comes standard with the pH and temperature probe option.

1.4 Included Items

LCA Model:	1	2	3
Probe	✓	✓	✓
Piston	✓	✓	✓
Magnetic Stirrer	✓	✓	✓
Stir Bar	✓	✓	✓
Sample Beaker	Opt	Opt	Opt
Power Cord	✓	✓	✓
pH Probe	Opt	Opt	✓
Coag / Poly Dosing Pump		✓	✓
Acid / Base Dosing Pump			✓
5 cc Graduated Cylinder		✓	✓

1.5 Options

1.5.1 pH and Temperature

Models LCA-1 and LCA-2 can be equipped with the pH and temperature probe option. This option comes standard on model LCA-3. The pH probe allows the user to easily perform pH adjustment prior to or during the coagulant titration. This option also allows the user to easily conduct testing for determining the isoelectric point.

1.5.2 Roll Away Case

The roll away case allows for easier transport and safe storage of the LCA.

1.6 Specifications

Dimensions	Width: 8.5" Depth: 9.2" Height (Stand Lowered): 26" Height (Stand Raised):
Weight	18 lbs. (8.2 kg)
Power Requirements	115VAC, 50/60Hz, 410 mA Optional 220VAC, 50/60Hz, 205 mA
Environmental Temperature	41-140°F / 5-60°C
Enclosure	Powder Coated Aluminum
Display	Backlit LCD
Measurements	LCA-1 -SCV (Streaming Current Value, or mV) -Manual/Hand Titration LCA-2: -SCV (Streaming Current Value, or mV) -Automatic Charge Titration -Coagulant Dose (ppm, mg/l) -Charge Demand (µeq/l) LCA-3: -SCV (Streaming Current Value, or mV) -Automatic Charge Titration -Coagulant Dose: parts per million (ppm) -Charge Demand: µeq/l -Automatic pH Titration -pH & Temp (F/C)* -Acid/Base Dose: parts per million (ppm)* -pH of isoelectric point (optional, requires pH)* *Also available as option on LCA-1 and LCA-2
Sample Size	225 mL to 2000 mL (250 mL, 1000 ml, or 2000 ml beaker sizes can be used, Beakers not included)
Materials in contact with sample	Delrin, 316 stainless steel, PTFE (magnetic stir bar)
Titration Pumps (LCA-2 and -3 only)	Solenoid operated micro-pump with 50 µl dispense volume. Material of construction: POM, PTFE, FKM. LCA-2 has single pump, LCA-3 has two pumps.
Titration Bottles (LCA-2 and -3 only)	250 mL Nalgene Bottles
pH Probe (Optional, Standard on LCA-3)	Measurement range 0 – 14.
Temp Probe (Optional, Standard on LCA-3)	Measurement range 0 – 140 F

1.7 LCA Components

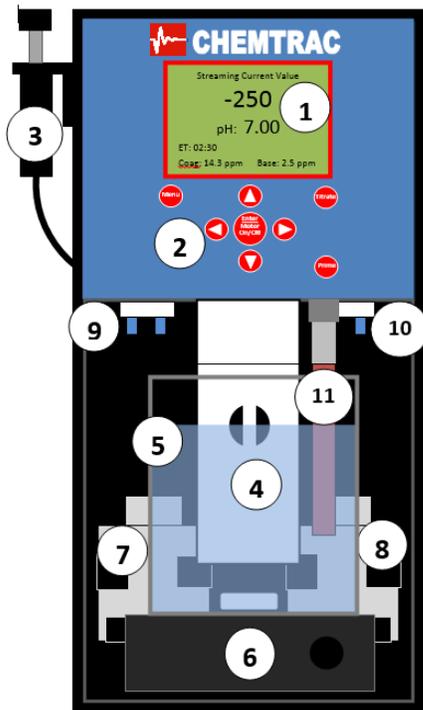


Figure 3 – LCA Components

1. LCD display
2. Keypad (Menu, navigation buttons, Motor Power, Titrate, & Prime)
3. Stand Release (raises & lowers stand)
4. Probe & piston
5. Beaker (optional, sizes may vary)
6. Magnetic stirrer with stir bar
7. Titrant container (coagulant, cationic Polymer) LCA-2 & LCA-3 Only
8. Titrant container (acid, base, anionic polymer) LCA-3 Only
9. Coagulant/polymer pump (LCA-2, -3)
10. Acid or base pump (LCA-3)
11. pH probe (optional, standard on LCA-3)
Temp probe (opt., standard on LCA-3)

1.7.1 LCD Display & Menu Keypad

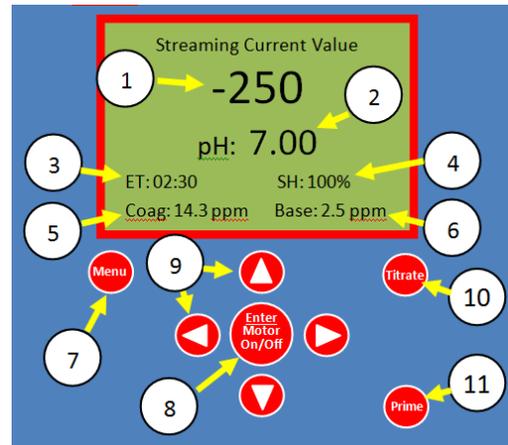


Figure 4 – Display & Menu Keypad

1. Streaming current value (charge). Range -1000 to +1000
2. pH reading. Range 0 to 14
3. Elapsed time. Shows how long the titration has been running
4. Signal Health. Reads >90% when probe signal is healthy. <90% could mean sensor needs maintenance, or possibly too much solids in the sample.
5. Primary dosing pump dosage. Shown here as coagulant dosage. Will display as ml, ppm, or $\mu\text{eq/l}$.
6. Secondary dosing pump dosage. Shown here as base dosage. Will display as ml, ppm, or $\mu\text{eq/l}$.
7. Menu button. Allows user to calibrate readings and change titrator settings
8. Enter button, and Motor On / Off button. Serves as "enter" button when in menu, and stops and starts the motor when in normal operation.
9. Menu navigation buttons
10. Titrate button. Starts the titration.
11. Prime button. Causes pump to dispense 50 strokes to prime and verify pump calibration.

1.7.2 Stand Release (Raise & Lowers Stand)

The Stand Release button on the left hand side of the enclosure is used to raise and lower the LCA so that a sample beaker can be placed under the sensor.

1.7.3 Probe and Piston

The probe and piston are both made of durable Delrin plastic. These are critical components of the LCA which produce the streaming current reading. Proper care and inspection of these parts is important to maintaining accurate charge measurement results. Refer to maintenance instructions in this manual for proper cleaning and care of these parts.

1.7.4 Beaker (Optional)

Beakers are not supplied with the LCA but can be ordered with the unit if desired. Various size beakers can be used with the LCA. The smallest beaker is a 250 mL and the largest size beaker that is typically recommended is 2,000 mL. Round or square beakers, glass or plastic, are fine to use.

1.7.5 Magnetic Stirrer and Stir Bar

The LCA is supplied with a magnetic stirrer and stir bar. The adjustable height of the LCA allows for other magnetic stirrer make & models to be utilized if desired.

1.7.6 Coagulant / Polymer Titrant Container

Models LCA-2 and LCA-3 come equipped with a 250 mL Nalgene Titrant Container for coagulant (e.g. Alum, Ferric) or polymer (e.g. Dadmac). This titrant container is located on the left side. The coagulant or polymer needs to be diluted down into a 1% (or less) solution.

1.7.7 Acid / Base Titrant Container

The LCA-3 has an additional titrant container on the right side that is to be filled with the appropriate acid or base solution. The acid or base titrant must be diluted (typically 1% or less)

and compatible (in the diluted form) with the following materials: POM, PTFE, FKM. Acetic acid is usually recommended when pH reduction is required prior to charge titration (typically required for higher alkalinity samples when using coagulants like alum, ferric, or low basicity PACl). A base like sodium hydroxide is recommended when pH needs to be raised during the titration to maintain optimum pH. The raising of the pH during the charge titration may be required on lower alkalinity / lower pH waters, especially when feeding acidic coagulants (e.g. alum or ferric).

1.7.8 Coagulant / Polymer Titrant Pump

The coagulant titrant pump (also referred to as the charge titration pump) is located to the left of the probe on models LCA-2 and LCA-3. Each stroke of the pump delivers approximately 50 μ l of coagulant. This pump cannot be used to titrate neat (undiluted) coagulants.

1.7.9 Acid / Base Titrant Pump

The acid/base pump (also referred to as the buffer pump) is located to the right of the probe on model LCA-3. Each stroke of the pump delivers approximately 50 μ l of buffer solution. This pump cannot be used to titrate neat (undiluted) buffers.

1.7.10 pH electrode and Temp probe

The pH electrode and temperature probe is optional on models LCA-1 and LCA-2, but comes standard on LCA-3 They are located to the right side of the LCA's probe. The pH probe is connected to a BNC male connector for easy removal. The temperature probe is permanently affixed to the LCA and cannot be removed (except by factory). The pH reading is very important to obtaining accurate charge readings and coagulant dosage determination on the LCA. The probe should be kept wet at all times and put into pH 7 buffer solution for short term storage. Place probe in KCl storage solution for longer term storage. Handle carefully to avoid dropping and damaging the probe.

2. User Menu

There are 3 main sections of the user menu which are titled:

1. Titration Setup (LCA-2 & LCA-3 only)
2. Calibration
3. Utilities

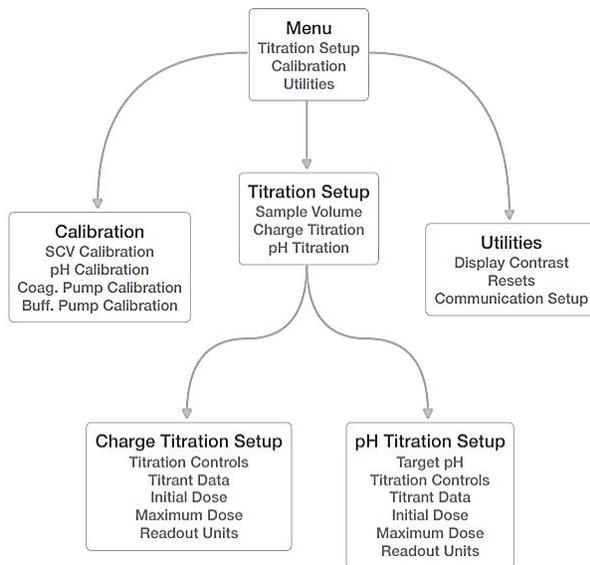


Figure 5 – User Menu Diagram

2.1 Titration Setup (LCA-2 & LCA-3 Only)

The Titration Setup menu is where settings relating to all aspects of the titration (e.g. titration controls, titrant data, sample volume, etc.) are to be found.

2.1.1 Sample Volume

Sample volume can be set for 1 to 2000 ml. The typical sample size will be 200 to 2000 ml when working with undiluted samples. Smaller volumes can be entered into the Sample Volume setting when working with diluted samples (e.g. 10 mL of sample diluted into 200 ml of DI water).

2.1.2 Charge Titration

This menu contains all the settings necessary for controlling the coagulant (or polymer) addition rate during the charge titration, as well as other functions discussed in sections 2.1.2.1 to 2.1.2.5.

These menu features are only available on models LCA-2 and LCA-3.

2.1.2.1 Titration Control

The Charge Titration Control menu allows the user to select between the following modes:

- Disabled – Turns off the charge titration feature and allows the LCA-3 to just perform a pH titration.
- Adaptive Fast – This is the recommended mode to use for charge titrations. The adaptive titration modes automatically speed up and slow down the rate of titration based on the rate of change in the charge reading. Adaptive Fast mode will complete the charge titration generally in 3 to 6 minutes. If charge titration finishes in under 2 minutes, there will likely be overshooting of the neutral endpoint, in which case Adaptive Slow mode should be used.
- Adaptive Slow – This is the recommended mode to use for charge titrations when Adaptive Fast proves to titrate too quickly and overshoots the neutral endpoint by more than 10 SCV units.
- Fixed Rate – This mode allows the user to customize the titration rate across 3 ranges. Using this mode, the titration rate could be set the same across all 3 ranges for a fixed rate of titration from start to finish, which can be useful for developing titration curves.

After selecting either the Adaptive Fast or Adaptive Slow modes, the next screen allows the user to select the “Initial” dosing rate (e.g. ppm per minute) that the pump will start off at, and also select the Minimum and Maximum dosing rates.

Set the “Initial” dosing rate to 50% of the typical coagulant dosage needed to treat the sample.

Set the “Minimum” dosing rate to equal 10% of the typical coagulant dosage needed to treat the sample.

Set the “Maximum” dosing rate to equal 50% of maximum coagulant dosage needed to treat the

sample (e.g. dosage required during rain events).

For example, if working with a raw water sample that typically requires a coagulant dosage of 10 ppm and sometimes the dosage needs to be as high as 50 ppm during rain events, then the following settings would be adequate.

Initial = 5 ppm (50% of typical 10 ppm dose)

Minimum = 1 ppm (10% of typical 10 ppm dose)

Maximum = 25 ppm (50% of max 50 ppm dose)

Using these settings, the LCA will automatically adjust the dosing rate based on changes it measures in the charge reading.

2.1.2.2 Titrant Data

For accurate parts per million (ppm) readout, the user must enter the % solution strength of the diluted coagulant solution (e.g. 1%).

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2.1.2.3 Initial Dose

If the sample being tested is always going to require a known minimum coagulant or polymer dosage, then enter that minimum dosage as the "Initial Dose." This can help reduce the time required to perform titrations.

2.1.2.4 Maximum Dose

Set for a value that is greater than the highest expected maximum dosage required to treat a sample. If the LCA is performing a titration and reaches this "Maximum Dose," it will stop the titration and display an error message. This prevents the pump from running continuously in the event the titrant bottle runs empty.

2.1.2.5 Readout Units

The dosage readout on the LCA can be set for ml (milliliter), ppm (parts per million), or ueq/l (micro equivalents per liter).

2.1.3 pH Titration (LCA-3 Only)

This menu contains all the settings necessary for controlling the acid or base addition rate during the pH titration, as well as other functions discussed in sections 2.1.3.1 to 2.1.3.6. These menu features are only available on model LCA-3.

2.1.3.1 Target pH

Set the target pH to the value needed to achieve accurate dosage determinations for the coagulant being utilized. If unsure what to use, go by the below table and make adjustments from there as needed.

Set the Deadband to 0.1 for most applications. The Deadband setting determines how close pH needs to be to the target pH before the titration is allowed to finished.

Why is there a Target pH? What do I use?

The pH is very important to charge measurement and to achieving accurate coagulant dosage determination. This is especially true when working with inorganic coagulants like alum or ferric. If these coagulants are fed into a raw water sample that is not in the ideal pH range when performing testing with the LCA, then the dosage determination will not be accurate. See section 3.1 (specifically 3.1.1.8 and 3.1.1.9) for more information on why Target pH is used.

2.1.3.2 Titration Control

The pH Titration Control menu allows the user to enable or disable the pH titration feature. It also allows for adjusting the dosing rate of the buffer during the titration.

Proportional Gain can be used to speed up or slow down the dosing rate. Raising the Proportional Gain will increase the rate at which the acid or base is dosed into the sample. Lower this setting slows down the dosing rate.

Adjust the Proportional Gain, and the Minimum and Maximum dosing rate as follows:

Prop. Gain – Typically set for 0.5. Raise to a higher value (e.g. 1.0) if the pH is dropping by more than 0.5 pH units away from Target pH during the charge titration, or if the pH adjustment is taking too long to complete after charge

reaches its neutral reading. **WARNING** – Setting the Prop. Gain setting too high can cause overshooting of the Target pH and result in inaccurate coagulant dosage determination. It is better for the pH adjustment to be on the slower side as this ensures more accurate coagulant dosage determination.

Minimum – Typically set for 1.00. This setting can be raised if pH adjustment is too slow to make the last final pH adjustment as the pH nears the Target pH.

Maximum – Typically set for 50% of whatever the highest dosage of buffer is going to be required.

2.1.3.3 Titrant Data

The pH Titrant Data menu allows the user to select whether an acid or base solution is being used with the auto titration pump. For accurate parts per million (ppm) readout, the user must enter the % solution strength of the diluted buffer.

2.1.3.4 Initial Dose

If the sample being tested is always going to require a known minimum acid or base dosage, then enter that minimum dosage as the “Initial Dose.” This can help reduce the time required to perform titrations.

2.1.3.5 Maximum Dose

Set for a value that is greater than the highest expected maximum dosage required to adjust the sample’s pH. If the LCA is performing a titration and reaches this “Maximum Dose”, it will stop the titration and display an error message. This prevents the pump from running continuously in the event the titrant bottle runs empty.

2.1.3.6 Readout Units

The dosage readout on the LCA can be set for ml (milliliter), ppm (parts per million), or ueq/l (micro equivalents per liter).

2.2 Calibration

The calibration menu allows the user to calibrate the Streaming Current Value (SCV). To calibrate the SCV, submerge the sensor in raw water (with not coagulant) and adjust the value to read -200 and press Enter.

The pH calibration can be performed using one, two, or three buffers. Or, simply perform a single point calibration to reference the pH reading to another recently calibrated laboratory pH meter.

3. Operation

3.1 Water Treatment – Determining Optimum Coagulant Dosage

3.1.1 Introduction

The LCA allows the user to quickly determine the optimum coagulant dosage needed to treat a sample of raw water for maximum turbidity and organics removal by finding the dosage required to neutralize the sample's charge. The test usually takes no longer than 5 to 7 minutes to perform. While the testing procedure for many WTPs will be very simple and only involve the addition of one or possibly two chemicals (e.g. coagulant and flocculent), there are a wide variety of scenarios in which the LCA is utilized and as a result some situations require a more comprehensive testing approach. Section 3.1 attempts to cover all the various considerations that can exist and offers up important guidelines and testing requirements that may need to be followed. While reading this section, please keep in mind that much of what is discussed may not apply to your situation.

To help our customers get up and running with the LCA as quickly as possible, we recommend you fill out the questionnaire located in the back of this manual and email or fax back to at us 770-447-0889 or chemtrac@chemtrac.com. Once your information is received, a product application expert will review the info and contact you with your personalized recommended testing procedure. Otherwise, there is a good deal of information contained in this section of the manual to help get started with the LCA. Having an understanding of coagulation chemistry as it relates to ionic charge of hydrolyzed coagulant species (of inorganic variety) will aid in one's understanding of much of the information provided here.

3.1.1.1 The Difference Between Online and Lab Charge (Streaming Current) Measurement

The LCA utilizes streaming current technology, but its application and response to coagulant can be very different from online streaming current (SC) measurement devices. Online SC devices are extremely useful for monitoring water quality

changes that impact coagulation, and even controlling coagulant dosage when conditions allow. But a limitation of online SC devices is that they provide a relative measurement of charge that can be impacted by various process conditions (pH, temperature, flow, etc), and thus the optimum charge value, or setpoint, is subject to change. The specific set of conditions required for the optimum charge value to remain consistent and predictable are generally only obtainable with laboratory measurement of charge.

The main factors that allow the LCA to accurately measure charge include maintaining the optimum pH range for SC charge measurements (which is coagulant specific), measuring the treated sample at the exact moment coagulant is being introduced, and maintaining a clean sensor. These factors are generally not obtainable with an online SC device. Very often the pH of the sample passing through the online SC device will be higher than the ideal range for charge measurement accuracy, and the sensor is often 30 seconds or more downstream of coagulant addition. And online charge readings are subject to change as process conditions such as pH and flow rate change, and as sensor fouling occurs. To get the most out of an online SC device, the user must perform routine maintenance and routinely determine an optimum dosage of coagulant using either traditional jar testing (30 to 60 minute test) or using laboratory charge analysis (5 minute test).

Unlike online SC devices, the LCA is capable of reliably performing this job because the necessary sample conditions (optimum pH, sample time, clean sensor) are easily met with a grab sample tested in the lab. This allows the LCA to quickly determine a coagulant dosage that is needed to reach full charge neutralization of raw water contaminants such as turbidity (NTU) and naturally occurring organic matter (NOM). Once the dosage is determined with the LCA, that dosage can be set for the process, and then the online SC device can be used to monitor for water quality changes that indicate an adjustment to coagulant dosage needs to be made. In many cases, the online SC device will guide the operator on how much of an adjustment is required, but occasionally the LCA will be needed to verify or determine an optimum dosage.

Note: Except under specific conditions, the LCA's reading will not match up with an online SC

instrument's reading very well. For example, if an online SC is reading 0 on a sample taken from the flash mix, a sample taken from the same point and measured by the LCA may read -20. This sort of discrepancy is not unexpected.

In order to compare readings and responses, the online and lab SC devices would need to operate under the exact same sampling conditions. For example, the lab unit could be used to compare against and verify the online SC instrument, but it would require taking a continuous flowing sample to the lab unit (e.g. into the beaker and letting it overflow) with the same approximate lag time and sample conditions as the online unit. Under these conditions, both the online and lab unit should provide comparative (yet both relative) response to treated water charge. What is important to understand is that the LCA exists for a specific purpose of finding optimum coagulant dosage under controlled conditions, and the online SC device exists for trending charge and helping guide dosage changes in real time as water quality changes.

3.1.1.2 Organics (NOM/TOC) Play Crucial Role in Charge Measurement

For a given mass, organics will exhibit a higher anionic charge than turbidity and potentially be a more significant determining factor in how much coagulant is needed to reach charge neutralization. Said another way, the sample being tested with the LCA will only reach a neutral charge when both turbidity and organics are neutralized with a sufficient dosage of coagulant.

3.1.1.3 Total Charge Neutralization Not Critical To All Water Treatment Scenarios

For conventional water treatment applications (i.e. coagulation followed by sedimentation and filtration), obtaining complete or nearly complete charge neutralization in a treated water sample will generally produce the best obtainable reduction in NTU/NOM for a given pH (Note: lower pH's generally allow for better organics removal). This is very important for drinking water applications looking to reduce disinfection byproducts to the highest level possible.

However, not all conventional water treatment applications require a "best obtainable" reduction of NTU/NOM. For example, water treatment

requirements for a paper mill will require a lesser degree of charge neutralization (or charge destabilization) as compared to drinking water as paper mills are generally not concerned with DBP's. Other applications like coagulant assisted membrane filtration, inline filtration, or applications using GAC filters, may achieve optimum reduction of NTU/NOM with a reduced coagulant dosage (i.e. less than what is needed to achieve charge neutralization).

In applications that don't rely on the coagulant to neutralize all (or nearly all) of the anionic charges in the sample, the LCA testing outlined in this manual may produce coagulant dosage determinations higher than what the process requires. A correlation between the test result and actual dosage requirement may be established for some applications, but certain other applications like inline filtration, may exhibit poor correlation due to process performance not being as strongly related to traditional mechanisms of coagulation.

3.1.1.4 Order and Methodology of Chemical Addition on LCA Not the Same as Traditional Jar Testing

The test performed with the LCA will predict the results of jar testing, but the testing procedure looks slightly different in terms of the order of chemical addition and the incremental titration of coagulant (and pH adjustment chemicals if necessary). One of the more confusing aspects to many new users of the LCA is that a flocculent is fed prior to the coagulant when doing coagulant determination testing on the LCA. The reason the flocculent is fed first is because an anionic or cationic polymer will likely impact the sample's coagulant demand. Meaning, if a cationic flocculent is fed to the process, it will usually reduce how much coagulant is needed to optimally treat the water because it imparts a cationic charge to the sample. Since the LCA is being used to determine how much coagulant is needed, the flocculent needs to be introduced so that any impact on charge from that chemical is taken into account.

It should be kept in mind that the agglomeration of particles and formation of floc plays no part in the LCA's measurement of charge neutralization, and this is why feeding the flocculent first is of no negative consequence. It is also why the sample

mixing time, and the incremental addition of the coagulant, are also not critical to the test results.

3.1.1.5 Oxidants Must be Fed to Sample if Fed to Coagulation Process

Any oxidants used in the coagulation process, like ozone or chlorine, are also fed to the sample prior to coagulant addition. Failure to do so may cause a significant increase in the dosage of coagulant required to neutralize a raw water sample.

3.1.1.6 Addition Rate of Coagulant is Important, Not Too Fast, Not Too Slow!

It is important that coagulant is added in a timely manner to the LCA's sample, but not so quickly as to cause overshoot of the neutral endpoint. It is not always possible, nor is it necessary, to bring the charge reading right exactly zero. Getting to within +/- 5 units is usually fine. It is also not required to have the charge stay right close to zero after the neutral endpoint is reached. Charge will often slowly drift negative with time because the coagulant hydrolyzes to a less cationic state. For this reason it is not recommended to titrate slowly or to wait for the reading to fully stabilize before adding more coagulant.

The basic procedure for titrating the coagulant into the sample is to add at least 50% of the expected coagulant dosage all at once and then start incrementally adding additional coagulant to the sample to bring the charge to zero within 5 minutes (3 to 4 minutes is ideal, 2 minutes or less is likely too fast and will cause overshoot). Do not wait for the reading to fully stabilize before adding more coagulant, and do not be too concerned with a 5 to even 10 unit overshoot of the endpoint. Experimentation and experience with the rate of titration is necessary in order to achieve accurate and repeatable results. Models with automatic titration capability will ensure the coagulant titration is performed in the proper time span and with minimum overshooting.

3.1.1.7 Mind the Pipette Tip When Titrating Coagulant Into Sample

It is generally recommended to feed ACH and PACl coagulants neat (undiluted). When doing so, it is important to pay attention to the pipette to make sure coagulant is actually flowing into the pipette (use fresh tips with each test to avoid tip plugging), and that there are not bubbles or air pockets in the pipette tip. Care should also be taken to ensure the tip is free of any droplets that may hang onto the outside surface. Do not hold the pipette tip against a cloth or paper towel in an effort to remove droplets as this will wick some of the coagulant out of the tip. A fast motion with a cloth is needed to wipe away droplets, or just wipe the tip across the edge of the lip on the container from which the coagulant was extracted.

When injecting the coagulant into the sample, point the pipette tip towards the edge of the beaker and away from the sensor opening so as to avoid having too high of a concentration of coagulant going directly into the sensor before a bit of mixing has time to occur. If coagulant goes into the sensor opening at a high concentration, this will cause the reading to climb very quickly towards zero and then swing back down rapidly and make managing the titration rate a bit more difficult. If the pipette tip is free of visible droplets of neat coagulant, it is generally OK to submerge the tip a couple inches below the sample surface to help avoid getting a higher concentration of coagulant entering the sensor, but care needs to be taken when doing so because any coagulant on the outside surface of the tip will cause error in the dosage determination.

3.1.1.8 pH Reduction of the sample may be necessary for accurate charge measurement

The pH is often a key parameter to consider for achieving accurate results with the LCA because the sample's pH determines the hydrolyzed coagulant species that are formed. As pH increases, less cationic (and even anionic) hydrolyzed coagulant species are formed. For example, the addition of aluminum sulphate to water that maintains a treated pH above 7.5 will result in the anion $Al(OH)_4^-$ being the predominant dissolved aluminum species. Because this species carries a negative ionic charge it is clearly not conducive to determination of optimum coagulant dosage using a measurement of charge neutralization. However, it is possible (and recommended in the test procedures) to reduce the sample's pH prior to the addition of

alum to a pH <7.0 to ensure the formation of cationic aluminum species like $Al(OH)_2^+$ and $Al(OH)^{2+}$. When the aluminum is sufficiently present as cationic species, it allows for reliable determination of optimum coagulant dosage using the LCA's measurement of charge neutralization.

Every coagulant has a slightly different pH range where measurements of charge neutralization will be able to achieve accurate dosage determinations. When performing charge neutralization measurements with the LCA, the ideal treated sample pH is usually near the coagulant's point of minimum solubility pH. For alum, this means charge neutralization measurement are best performed at a treated water pH (pH after addition of coagulant) in the 6.0 to 6.5 range (although testing is sometimes done at a lower pH if the water treatment plant happens to operate at pH <6.0). For high basicity (i.e. pre-hydrolyzed) coagulants like ACH, the pH can be as high as 7.5, and possibly 8.0, and still allow for reliable dosage determination using the LCA.

If a coagulant's point of minimum solubility is unknown, a way to find the optimum pH range for any coagulant is simply to add what is known to be an optimum dosage of coagulant to a sample of raw water (in accordance with testing guidelines outlined in this manual) at various starting pH's (e.g. 8.0, 7.5, 7.0, 6.5, 6.0). One jar is tested at a time to see which sample comes closest to neutral after the addition of the optimum dosage of coagulant (Note: the optimum dosage being fed all at once and not incrementally titrated). Then measure that sample's pH and you now have the "target pH" that can be used when performing charge neutralization test with that specific coagulant.

Note: For the purpose of determining a coagulant's "target pH" for charge neutralization measurements as described above, optimum dosage of coagulant must be defined as the dosage that achieves best obtainable reduction in turbidity and organics. In the below table, jar #4 would be considered "optimum."

1	2	3	4	5
10 ppm	12 ppm	14 ppm	16 ppm	18 ppm
2.0 NTU	1.3 NTU	1.0 NTU	0.95 NTU	1.1 NTU
1.0 mg/l TOC	.8 mg/l TOC	.6 mg/l TOC	.4 mg/l TOC	.35 mg/l TOC

The below table shows an example of "Target pH" testing results. Each sample had its pH modified with an addition of acid prior to the addition of coagulant, and this was referred to as the Start pH. In this example, sample B was closest to neutral after the addition of an optimum dose of coagulant (determined in above testing). Sample B's ending pH (i.e. treated pH) was 6.5. This makes 6.5 the target pH for that coagulant in future testing.

	A	B	C	D
Start pH	7.5 pH	7.0 pH	6.5 pH	6.0 pH
Coag Dose	16 ppm	16 ppm	16 ppm	16 ppm
Charge	-60	-5	+25	+95
End pH	7.3 pH	6.5 pH	5.8 pH	5.2 pH

The "optimum" target pH can change slightly due to large changes in sample temperature, such that the target pH may be slightly lower in the summer and higher in the winter. By heating and cooling a given sample prior to titrating with coagulant, empirical test data can be easily developed to see how temperature may impact the target pH value.

Note: If a process is running at a lower pH (i.e. lower than the coagulants "point of minimum solubility"), then the recommendation is to target whatever treated pH (pH immediately post coagulant addition) that the process is setup to operate at.

NOTE: Buffering a sample so that an instrument can measure the specific ionic species is commonly done with instrumentation, so there is nothing unusual about doing the same on the LCA. Consider amperometric chlorine measurements as an example. With that technology, acetic acid is commonly used to lower the pH below 6.5 to convert all the chlorine to hypochlorous acid (HOCl). This is done because amperometric chlorine analyzers cannot measure the chlorite (OCl) ion that forms at higher pH.

Keep in mind that the dosage determined by the LCA will be the optimum dosage for the water treatment process (in most cases) even if the process runs at a different pH from what was used with the LCA's testing. So there is no need to match the LCA's sample pH to the process or vice versa. Although, sometimes the target pH will certainly be the same as the process pH and this is usually advantageous for the water treatment process because it

means the charge neutralization mechanism of coagulation will work even more effectively!

3.1.1.9 Addition of base may be necessary to maintain target pH during coagulant addition

As discussed in section 3.1.1.8, it is sometimes necessary to reduce the sample pH in order to ensure accurate dosage determination. The amount of acid needed to achieve optimum testing results on the LCA is usually predictable once the operator has some experience with testing, but the acid dose can be difficult to guess during times when raw water quality conditions have changed significantly due to a rain event. During these sorts of events, the subsequent addition of coagulant following the addition of acid can result in the pH dropping too low (i.e. lower than what is seen as necessary to achieve accurate results based on experience). When an excessive drop in pH is seen to occur while adding coagulant, the option would be to start the test over and feed less acid prior to titration with the coagulant, or simply raise the pH back up to the target pH value using a dilute (e.g. 1%) solution of caustic. The addition of caustic prevents one from having to start the testing all over. As long as the amount of caustic added does not exceed the target pH, and as long as only small amounts of caustic are needed (e.g. <2 ppm) the caustic itself will have virtually no discernible impact on the testing result. If using an LCA-3, the addition of caustic to maintain target pH is automated and the customer need not be overly concerned with how much acid is added at the start of the titration.

3.1.1.10 Determining optimum dosage of caustic or lime

When working with lower alkalinity samples and feeding an acidic coagulant like alum or ferric, it may be necessary for the WTP to also feed a base (e.g. caustic or lime) to maintain sufficient alkalinity and an optimum pH for coagulation. In these cases, the LCA is an excellent tool to help an operator not only determine the required dosage of a coagulant, but also determine the optimum dosage of a base that is fed to the coagulation process. In many cases, WTP's find they can significantly reduce their dosage of Alum

and Lime dosages to what the LCA's test results indicate and achieve better treatment results.

When charge testing shows these dosages can be significantly reduced, there is typically a lot of concern about making the reductions because the WTP may have been using the higher dosages for many years, even decades and will often be convinced these higher dosages are required to achieve optimum treatment results. Chemtrac has several case histories where plants were at first very reluctant to make the reductions, but realized significant benefits in reduced chemical cost, reduced sludge disposal, longer filter run times, and reduction in disinfection byproducts (DBP). This is not to say that sometimes higher dosages of lime and alum may be required to achieve treatment goals, but very often this proves to not be the case and a WTP stands to benefit greatly if they remain open to this possibility.

3.1.1.11 Note on Coagulant Dilution

It is generally recommended to not dilute pre-hydrolyzed coagulants like PACl and ACH, as they can lose their charge density, resulting in a higher dosage of coagulant needing to be fed to achieve charge neutralization. This would potentially result in significant error in coagulant dosage determination. Try comparing testing results on the LCA feeding these coagulants both undiluted (neat) and diluted to see how much dilution impacts the required dosage to reach neutral charge. If these coagulants are being diluted, it is important to make fresh solutions daily.

3.2 Preparation for Sample Testing

It is recommended to clean the LCA Sensor and sample beaker as detailed in section 4.2 of this manual before conducting a titration.

3.2.1 Collect Raw Water Sample

It is recommended to use a minimum sample volume of 1000 ml (or whatever sample size is being used in the plant's jar testing device to make dosage calculations equivalent). Collect enough sample to perform at least two tests. When collecting a sample for analysis with the LCA, observe these important guidelines:

- The sample must be taken upstream of coagulant addition and not contain any coagulant.
- The sample should be taken ahead of the addition of any pH adjustment chemicals like lime or caustic if fed to the coagulation process. This is necessary because the optimum pH for the LCA test may look different from the pH value that is being maintained for the water treatment process. But even if pH targets are the same for both, it is best to feed the coagulant first and only add lime/caustic as needed to maintain pH at the target pH. In this way, an accurate dosage of both coagulant and base can be determined.
- All other chemicals that are fed to the coagulation process (chlorine, potassium permanganate, coagulant aids, flocculants, powdered activated carbon, etc) need to be included in the sample that is tested on the LCA. This is especially true of any oxidant fed ahead of or immediately following coagulant addition.
- Look to see if a sample point exists that allows for the collection of a sample that has one or more of the treatment chemicals already present. This can save time in preparing a sample for testing. Some chemicals will be fed at the same location or downstream of the coagulant and will therefore have to be manually introduced after the sample is collected, making sure those chemicals are introduced at the same dosage as what is being fed to the process.

When collecting a sample that contains some of the process additives, ensure it is at a point where adequate mixing/distribution of those chemicals has occurred. If in doubt, or if LCA testing proves to be not very repeatable, it is advised to grab a raw water sample without any treatment chemicals and then manually add those chemicals to the jar to ensure proper dosages of those chemicals is obtained.

3.2.2 Prepare Sample for Testing

Once a sample has been collected, prepare fresh dilute solutions (e.g. 1% solutions) of treatment chemicals that are used in the coagulation step of the process and not already contained in the sample. Feed the chemicals, with the exception of the coagulant and chemicals used to adjust pH, at the appropriate dosages to the sample immediately before testing the sample on the LCA. Coagulant (and if necessary lime/caustic) will be added during the sample titration phase. As discussed in section 3.1.1.4, it is recommended to go ahead and feed flocculent (if used) to the sample prior to submerging the sensor in the sample. Ensure the sample is being mixed with the magnetic stirrer while chemicals are being added.

NOTE: Experimentation is recommended to see if flocculants have any impact on the testing results, or if the impact is repeatable enough across various sample conditions to allow the exclusion of that process additive from future testing. For example, if a cationic flocculent fed at 0.5 ppm is found to reduce the demand for coagulant by 3 ppm across a wide range of samples (with various NTU and TOC levels), then the flocculent can be excluded from testing and the operator would just subtract 3 ppm from the testing result to account for the flocculants portion of charge neutralization.

3.2.3 Positioning Sensor into Sample

Positioning the sensor into the sample requires raising and lowering the LCA stand. The adjustment capability of the stand allows the user to incorporate a wide range of beaker sizes, as well as magnetic stirrers with bases of different sizes.

To raise the stand, first grip the stand release handle (on left side) and depress the release button. While continuing to hold the button down, use a lifting motion to raise the stand (Note: slightly push down on the top of the LCA while pressing the release button if it is difficult to get to rise. This will get the lift mechanism to release). After raising the stand, place the sample beaker on the magnetic stirrer under the sensor and then lower the stand by depressing

the stand release button and then applying pressure to top of LCA to lower the sensor into the beaker. Once the opening on the side of the sensor is just below the sample surface (as shown in Figure 6), release the button and the stand will stay locked in place.

Warning: Be sure to not submerge the sensor below the thumbscrew on the front of the probe!! This will cause inaccurate readings and lead to corrosion of the electrical connections.

As shown in Figure 6, submerge the probe so that the sample comes up to the openings in the probe. Sample should cover the hole halfway or be just at the top of the hole. Do not lower the stand so far such that the sample goes above the black thumbscrew. Keep the sample away from reaching the electrical connections at the top of the probe!

Getting these wet can create signal error and potentially cause corrosion on the connections.

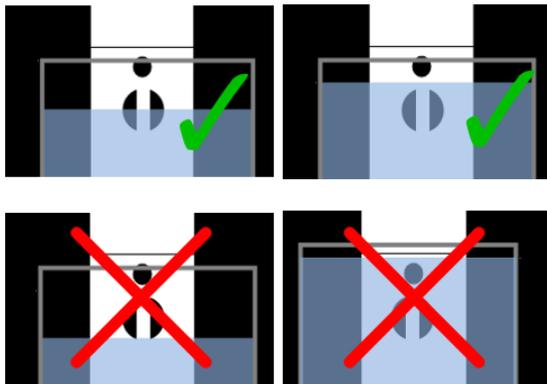


Figure 6 – Optimum Depth of Probe in Sample

3.2.4 Sensor Conditioning & Stabilization

Once the sensor is submerged into a sample, turn the motor on by pressing the **Enter** button. Allow at least 1 minute for the sensor to condition and the reading to stabilize. While the reading is stabilizing, take time to ensure all the necessary treatment chemicals have been added to the sample at the proper dosages.

3.2.5 pH Measurement and Adjustment

It is recommended to consider measuring the sample pH prior to and possibly during the titration when using inorganic coagulants (e.g. alum, ferric, and PACl). This is recommended because in some cases pH adjustment is required before or during the titration to achieve accurate dosage determination. It is highly recommended to review sections 3.1.1.8 and 3.1.1.9 of this manual for more information on the importance of pH measurement and establishing a target pH for the specific coagulant being used.

3.2.5.1 pH Probe

All models of the LCA (-1, -2, and -3) can be outfitted with a pH probe. If the LCA-1 or LCA-2 were ordered without pH, it will require the analyzer to be returned to the factory for the pH upgrade. The LCA-3 comes standard with pH measurement capability, as well as an automatic pH adjustment feature using an acid or base.

The user can also utilize their existing laboratory pH probe. With a 1 to 2 liter sample size, there is sufficient room in the beaker to accommodate the LCA sensor and a laboratory pH probe. Attaching a clip to the probe so it can hang on the side of the beaker is recommended.

It is recommended to calibrate the pH probe daily. A single point calibration on a pH 7 buffer may be sufficient, but 2 or 3 point calibrations should be performed weekly.

3.2.5.2 Determine Target pH

The target pH is defined as the pH that produces the most accurate dosage determination on the LCA. Some coagulants, like ACH, may not require any sample pH measurement or adjustment during any part of the test. Other coagulants, like PACl, may require the pH to be initially adjusted down with the addition of an acid prior to the addition of coagulant, but require no further pH adjustment during the actual titration.

But in other situations, namely when dealing with low alkalinity samples and feeding acidic coagulants like alum, the sample pH may require

attention throughout the titration and the user may need to feed a base (e.g. caustic) to keep the pH in an acceptable range (+/-0.3) of the target pH.

Below are examples of pH targets that are commonly suggested as starting points in testing when using these coagulants. Realize that many coagulants are “blended” or otherwise custom designed products that may require some experimentation to determine their best “Target pH.” Steps for determining the Target pH are discussed in section 3.1.1.8.

Coagulant	Target pH (+/- 0.3)
Alum	6.5
Ferric	5.5
ACH	7.5
HB PACI	7.0
MB PACI	6.8
LB PACI	6.5

3.2.5.3 Considerations if lowering sample pH becomes necessary

If it is necessary to lower the sample pH, any acid can be used. Consider using carbonic acid (soda water) as this has the least impact on the sample’s alkalinity and helps maintain the sample’s buffering capability which keeps pH more stable (closer to target pH) as coagulant is introduced.

3.2.5.4 Considerations if raising sample pH becomes necessary

If it becomes necessary to feed a base (lime/caustic) to maintain the target pH, the base should ideally be added during the titration procedure, and only after the pH has dropped 0.3 to 0.5 pH units below the target. Once the pH drops this amount, proceed with adding the base and raise the pH to the target pH, but taking extreme care to not overshoot the target pH! Overshooting the target pH with base can result in having to feed more coagulant than would otherwise be necessary to reach the neutral endpoint. Continue adding coagulant, and base as necessary, until the neutral endpoint is reached at a pH value that is at least within +/- 0.3 units of the target pH.

3.2.6 Titration Procedure

With the completion of the previously discussed steps, the sample is ready to be titrated with the coagulant. For model LCA-1 (or when feeding neat coagulant), this means manually adding the coagulant in incremental dosages until the neutral endpoint is obtained. The target time to titrate the sample to a neutral charge should be 2 to 5 minutes. Figure 7 shows an example of how the incremental dosages and resulting charge response may appear. The first dose fed to the sample when doing manual titrations should be at least 50% to 75% of the expected dosage. Then smaller incremental additions should be made from that point until neutral charge is reached.

Once the neutral endpoint is reached (at the target pH), the test is complete. Simply determine what volume of coagulant was required to reach neutral and calculate the parts per million (ppm) or mg/l dosage.

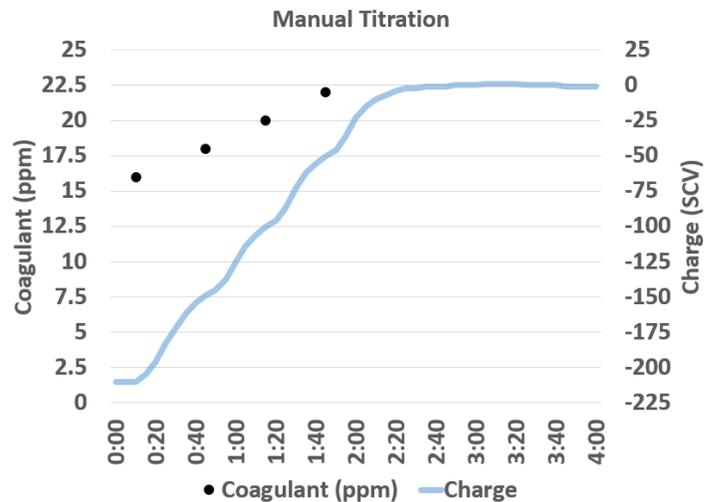


Figure 7 – Manual Titration

If using the LCA-2 or LCA-3, the coagulant titration can be performed automatically when using dilute coagulant solutions. It will be necessary to first program the Charge Titration controls as outlined in section 2.1.2.

Once programmed, the titration can be started by pressing the “Titrate” button. The titration profile will appear similar to what the graph illustrates below. Each dot on the graph represents a single pump stroke of the titrant pump. Each stroke dispenses approximately 50 uL of coagulant,

which works out to 0.5 ppm per stroke dosage if using a 1% solution of coagulant and 1,000 mL sample size.

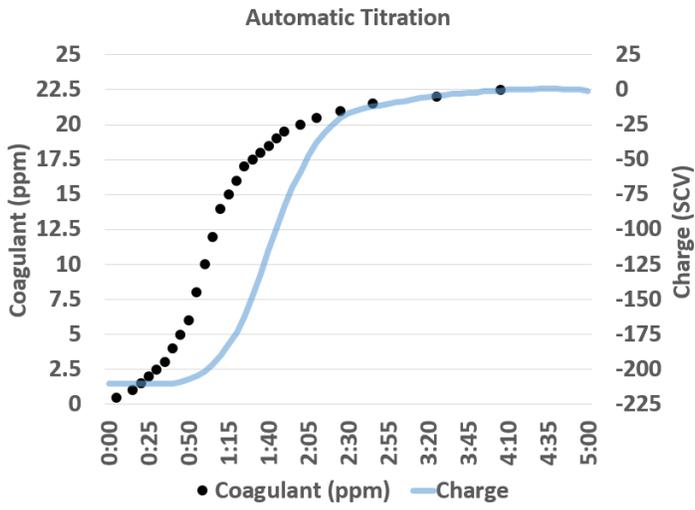


Figure 8 – Automatic Titration

4. Maintenance

4.1 Signal Health Readout

Located on the front display is a percent (%) readout labeled “SH” which stands for signal health. The signal health readout is diagnostic analysis of the streaming current waveform that is generated by the sensor. This signal is an approximate 4 hertz sine wave. If the signal has a near perfect sinusoidal shape, then the signal health readout will be 100%. The signal health readout is only valid when the LCA reading is sufficiently anionic or cationic in value. If the LCA reading is within +/- 30 units of zero, the signal becomes very small and meaningful analysis of the waveform is no longer possible. Therefore, the signal health readout should be evaluated prior to starting the titration to ensure it is better than 90%.

The signal health will drop below 90% for the following reasons:

1. **Sensor is fouled.** Certain types of sensor fouling can cause the signal to be unstable. Anytime the signal health is erratic or falling below 90%, it is recommended to first try cleaning the probe and piston **Note:** A signal health reading of >90% does not indicate the probe is clean and does not require cleaning. The sensor can be fouled or have a residual substance impacting the measurement results and still exhibit a 100% signal health. If tests results do not seem accurate or repeatable, always try cleaning the probe and piston as the first troubleshooting step.
2. **Too high of solids in the sample.** A disrupted signal health is especially likely if there are larger solids, like fibers, or substances like greases in the sample. If the signal health is near or below 90% and/or the reading appears unstable, it is recommended to strain out the larger solids using a 200 mesh (74 micron) or finer screen. Particles >10 micron generally do not contribute in any meaningful way to the charge reading or the titration result.
3. **Loose motion in drive linkage.** After long term or heavy use, the LCA’s motor or drive linkage may begin to wear down and cause unstable motion in the piston.

This will cause the signal health value to drop and indicate factory maintenance of the motor or drive linkage assembly is required. To prevent premature wear on the drive linkage, it is best to only run the LCA motor as needed and not leave running on a continuous basis.

4. **Electrical Interference.** A strong enough source of electromagnetic interference (EMI) in close vicinity of the LCA could potentially disrupt the signal and cause unstable readings and changes in the signal health readout.

4.2 LCA Sensor Cleaning

The cleaning method and frequency of the LCA sensor will depend on the application. Cleaning is generally recommended between each test. Through comparative testing, some users may find that cleaning between each test is not necessary. However, cleaning is always recommended prior to using the LCA if its “last use” condition is unknown (e.g. a different operator had previously conducted testing on the LCA). **Once a day cleaning should be performed at a minimum.**

Avoid touching the portion of the piston that fits down inside the probe bore (between the electrodes), and do not use towels to dry any surfaces of the piston, probe, or beaker that will come into contact with the sample. Towels can leave a residual. A very tiny amount of residual substance transferred onto the piston from a towel or finger can impact the test results.

4.2.1 Cleaning Procedure

- Make sure the thumbscrew on front of probe is not screwed down tight.
- Pull down on the probe to detach.
- Unscrew piston by turning counter clockwise (only touch the very top part of piston)
- Take the parts to a sink where they can be brushed under running tap water using the supplied brush or any available plastic bristle brush. Note: make sure brush is clean and has not been used to brush anything besides the LCA probe and piston.
- Brush all surfaces of the piston thoroughly and then rinse thoroughly with DI water and shake off excess.

- Immediately reattach the piston to the LCA being careful to only touch the top portion of the piston.
- Brush all surfaces of the probe below the thumbscrew, try to avoid getting the plugs on top of the probe wet. Pay particular attention to brushing inside the probe's bore where the electrodes are located. Use the supplied brush or any clean plastic bristle brush that easily fits into the 0.5 in (13 mm) opening. **Warning:** Do not force a brush into the bore! **Note:** The plug in the bottom of the probe can be removed to facilitate a more thorough cleaning if necessary. Be careful to not lose o-ring located under the plug.
- Thoroughly rinse probe with DI water. Shake off excess water. **Note:** Use paper towel to dry top of probe around the plugs (area above thumbscrew). Do not dry the surface of probe that will be submerged in sample.
- Reattach the probe onto the LCA, making sure the thumbscrew is facing towards you.
- Brush the sample beaker under running tap water and rinse with DI water and shake out excess water. Only dry outside surface of beaker with cloth.

4.2.2 Use of Approved Cleaners

Cleaning with a chemical is usually only required on an infrequent (e.g. weekly) basis to prevent the parts from staining, or if the sensor is exposed to a more tenacious chemical or an overdose of a chemical. Most residuals that are left on the sensor surfaces after conducting a titration are easily removed using the above procedure.

A recommended procedure for evaluating what level of cleaning an application requires is to conduct several titrations in a row of a static sample (e.g. sample collected in 5 gallon bucket) being sure to perform the above cleaning procedure between each test. If there is a "residual effect", the coagulant dosage result will typically drift in one direction with each successive test (e.g. taking slightly less coagulant to reach neutral with each successive test). If this appears to be occurring, try using an approved cleaner as part of the cleaning procedure. If this improves repeatability in the testing, then the cleaner is clearly required and should be incorporated into the routine cleaning procedure.

Note: If a cleaner is used, it is important to rinse the parts thoroughly with tap water and then DI water to flush away as much of the residual cleaner as possible.

4.2.3 List of Approved Cleaners For LCA Sensor

It is important the cleaner that is used is safe on Delrin plastic and 316 SS. The cleaner also needs to ideally rinse away easily and leave no (or minimum) residual. Avoid cleaners with dyes, fragrances, and other additives not necessary to cleaning performance.

Approved cleaner's include:

- **Mild detergent** like trisodium phosphate, (Note: Avoid detergents with dyes or fragrances as they leave a residue that can impact the reading). Safe for soaking.
- **Oxalic acid.** Safe cleaner for removing iron and manganese. Safe for soaking.
- **5% (or less) Acetic Acid / White Vinegar** (Note: Do not soak parts in acetic acid as long term exposure can degrade Delrin. Recommend to spray on, scrub, and then rinse off thoroughly)
- **5% Acetic Acid with 3% Hydrogen Peroxide (50/50)**, great for cleaning off iron/manganese (Note: Do not soak parts in this solution as long term exposure can degrade Delrin. Keep exposure time to <1 minute. Recommend to spray on, scrub, and then rinse off thoroughly.)
- If above cleaners do not remove stains that have developed on probe and piston surfaces, a power cleaner containing bleach can be used. (Note: Do not soak parts in these cleaning products. Avoid products with dye or fragrances. This type of cleaner is more likely to leave a residue, so rinse thoroughly. There is no concern with the slight abrasiveness of these cleaners as short term exposure will not harm the sensor.)

4.3 Titrant Pump Cleaning / Maintenance

The titrant pump(s) should be flushed with DI water whenever not in use for more than 12 hours. To flush, place pump tubing in container of DI water and press the “Prime” button and approximately 2.5 mL of DI water will be flushed through the pump. The pump can be left with DI water inside, or primed again (with tubing removed from DI water container) to purge out most of the DI water.

If the titrant pump is not pumping or delivering a consistent volume when performing pump calibrations, it is recommended to first inspect and/or replace the pump tubing. If air bubbles appear in the tubing while the pump is operating, that would suggest a leak at one of the two pump head fittings. If inspection and replacement of the tubing does not resolve the performance issue, try flushing the pump with a mild detergent solution, acetic acid, or 3% hydrogen peroxide. If these cleaners do not restore proper operation, the pump can be removed for disassembly, inspection, and cleaning.

The pump is held in place by a clip and is easily removed for service or replacement. To remove the pump, first disconnect the tubing by unscrewing the blue tubing connectors from the pump. Then grab onto the white portion of the pump that sticks out from the bottom of the enclosure and apply a slight twisting motion while gently pulling down on the pump to remove it from the mounting clip (the clip cannot be seen until the pump is removed). Once the pump detaches from the clip, disconnect the pump leads at the connector located a couple inches above the pump. **Note:** Some early model LCA's were not designed with a detachable connector. Contact the factory for the connector which can be installed by the customer.

With the pump removed, the pump head can be taken apart by unscrewing the two visible Allen head screws. Once the screws are removed, the pump head should be carefully taken apart so as not to lose the two small duck bill check valves. The check valves can be easily removed, inspected and cleaned. The duck bill check valves can also be replaced if they appear to not be closing properly, or no other obvious causes to pump performance issues are seen. The body of the pump head should also be inspected and cleaned to remove any particulate, film or other buildup. The re-assembly of the pump head is straight forward as the check valves can only go

back in one direction and the pump head has a positioning pin to prevent improper assembly.

Reconnect the pump wires once the pump is reassembled and ready to reinstall. Note: There is not polarity that needs to be observed when reconnecting the pump wires.

Take special care when re-installing the pump into the LCA's mounting clip. Do not try to push or force the pump straight up into the clip as the clip opening is too small to allow the pump to slide back into position in this manner. Instead, place the top of the pump (round, silver portion) against one side of the clip and apply pressure to push that side of clip out a small amount so as to open the clip slightly, which will then allow the pump to more easily slide up into the clip opening. Once the pump is started back into the clip, simply push up on the body of the clip while applying a slight twisting motion to help the pump slide into position. Hook the tubing connectors back into the pump head and then prime and calibrate the pump multiple times to verify repeatable operation. If the pump is still not repeatable, the pump can be sent back to factory for repair, and/or replaced by the customer.

4.4 pH Probe Cleaning

Cleaning is required whenever deposits or contaminants appear on the probe's measurement surfaces. Symptoms that signal the need for cleaning/reconditioning include slower than normal response and/or inaccurate readings.

To clean the probe, use clean water and a soft clean cloth, lens cleaning tissue or cotton swab to carefully remove all foreign material from the glass bulb and the reference / junction material that sits behind the bulb. **Warning:** pH glass bulbs can break very easily, apply very gentle pressure when cleaning.

If pH readings are still inaccurate or response is sluggish, additional cleaning may be required. The following steps are recommended:

Step 1: Soak the probe for 10-15 minutes in clean water containing a few drops of commercial dishwashing liquid. GENTLY clean the glass bulb and the reference / junction material that sits behind the bulb by rubbing with a cotton swab soaked in the cleaning solution. Rinse the probe in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water.

If proper pH response is not restored, continue with step 2.

Step 2: Soak the probe for 30-60 minutes in one molar (1 M) hydrochloric acid (HCl). This reagent can be purchased from most laboratory supply dealers. Be sure to follow the safety instructions included with the acid. GENTLY clean the glass bulb and the reference / junction material that sits behind the bulb by rubbing with a cotton swab soaked in the acid. Rinse the probe in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water. To be certain that all traces of the acid are removed from the probe crevices, soak the probe in moving (e.g. stirred) clean water for a minimum of one hour. Readings may take a few hours to stabilize after cleaning with Acid.

If proper pH response is not restored, continue with step 3. **Caution:** make sure acid from previous step does not come into contact with chlorine bleach in following step. Toxic gases can be formed from reaction between acid and chlorine!

Step 3: Soak the probe for approximately 1 hour in a 1 to 1 dilution of commercially available chlorine bleach. Rinse the probe with clean water and then soak for a minimum of 1 hour in moving (e.g. stirred) clean water to remove residual bleach from the junction. Then re-rinse the probe with clean water and retest. Readings may take several hours to stabilize after cleaning with bleach.

It will be necessary to replace the pH probe if none of the above cleaning steps restores proper performance.

4.5 Storage

4.5.1 LCA Storage

When not in use, the LCA should be cleaned according to recommendations using an approved cleaner, being sure to rinse sensors parts thoroughly with DI water afterwards. Store the sensor dry.

4.5.2 pH Probe Storage

Prior to long term storage of the pH probe, it is recommended to clean The pH probe should be stored in a KCL solution (3 mol/l) or pH 4 buffer solution

4.6 LCA Sensor Check and Calibration

4.6.1 Basic Function Test

The following procedure is a basic function test of the LCA Sensor:

- Press the “Enter – Motor On/Off” to stop the motor.
- Remove the probe.
- Press the “Enter – Motor On/Off” to start the motor. Piston should be seen traveling up and down.
- Verify reading charge reading is 0 (+/-1)
- Press the “Enter – Motor On/Off” to stop the motor and reattach the probe.
- Place raw water (untreated) sample under the sensor.
- Reading should be -100 to -400.
- Dose sample with coagulant and verify reading can be titrated to zero (0). Note: If sample is low alkalinity water, it may require addition of lime or caustic if pH drops below 5 before the neutral endpoint is reached.

4.6.2 Test Procedure Using Verification Solutions

Chemtrac offers verification solutions to check the neutral endpoint accuracy of the LCA. These solutions are labeled “Verification Solution #1 – Anionic” and “Verificatoin Solution #2 – Cationic”. Both solutions are made down to the same charge strength such that one part of solution #1 is neutralized by 1 part of solution #2. The below procedure describes the verification procedure:

- Clean the probe and piston and sample beaker (a small 250 or 500 ml glass beaker can be used for this test) in accordance with section 4.2. Be sure to rinse parts thoroughly with DI water.
- Fill the sample beaker with DI water.
- Inject the sample with 10 ml of solution #1 (Anionic).
- Place sample under the LCA and allow reading to stabilize. Reading should be at least -100.
- Start titrating the sample with solution #2 (cationic). Start by injecting 9 ml of the solution. This will cause reading to go slightly less negative, but should not bring the reading to zero.

- Slowly add additional solution in 0.2 mL increments waiting several seconds between additions to see if the reading starts to change rapidly.
- Once the reading starts to change rapidly, wait to see if reading crosses over the neutral endpoint before adding any additional cationic solution.
- The neutral endpoint should be reached reached after adding 9.2 to 10.8 ml of solution #2.

If the titration results are not in the above range, it is suggested to clean the sensor again (but do not use any cleaners) and rinse the parts thoroughly with DI water and re-test. Contact factory for assistance if the LCA does not pass the verification test.

4.7 Application Questionnaire

For each of the below items, please be sure to include the appropriate "units of measurement" (e.g. MGD, m³/hr, ml/min, etc.

Raw Water:

- Flow Typical: _____ Min: _____ Max: _____
- Alkalinity Typical: _____ Min: _____ Max: _____
- pH Typical: _____ Min: _____ Max: _____
- TOC/UVA Typical: _____ Min: _____ Max: _____
- Turbidity (NTU) Typical: _____ Min: _____ Max: _____
- pH (Post Coag) Typical: _____ Min: _____ Max: _____

Is Jar Testing Routinely Performed: _____ Yes _____ No

Primary Coagulant: _____ Chemical Concentration¹: _____ %

Weight/SG²: _____ Basicity (PACI/PAC/PAS): _____ %

Please list actual coagulant type (aluminum sulfate, ferric chloride, polyaluminum chloride/PAC, etc), and chemical concentration if known (e.g. 48.5% aluminum sulfate, 8% Al₂O₃). If coagulant is a pre-hydrolyzed product (e.g. PAC), please list basicity of the product.

Coagulant Feed Rate (e.g. ml/min): Typical: _____ Min: _____ Max: _____

Coagulant Dosage (ppm or mg/l): Typical: _____ Min: _____ Max: _____

Because WTP's can calculate their dosage various ways, we ask that you provide both the feed rate in ml/min as well as the ppm or mg/l dosage. This allows us to work out how dosage is being calculated (e.g. as liquid product, as dry aluminum sulfate, as aluminum oxide, or as aluminum). This is very important to establishing the proper instrument settings on the LCA for automatic titration and dosage determination purposes.

Secondary Coagulant: _____ Chemical Concentration¹: _____ %

Weight/SG²: _____ Basicity (PACI/PAC/PAS): _____ %

A secondary coagulant is defined as any inorganic or organic product that is fed along with the primary coagulant that aids in charge neutralization (e.g. a low molecular weight polymer like DADMAC). Please list actual coagulant type (aluminum sulfate, ferric chloride, polyaluminum chloride/PAC, etc), and chemical concentration if known (e.g. 48.5% aluminum sulfate, 8% Al₂O₃). If coagulant is a pre-hydrolyzed product (e.g. PAC), please list basicity of the product.

Coagulant Feed Rate (e.g. ml/min): Typical: _____ Min: _____ Max: _____

Coagulant Dosage (ppm or mg/l): Typical: _____ Min: _____ Max: _____

Flocculant: _____ Anionic ___ / Cationic ___ Concentration¹: _____ %

Flocculant is a high molecular weight polymer that is fed to bridge coagulated particles into larger floc agglomerations. Please list actual polymer type and polymer concentration.

Flocculant Feed Rate (e.g. ml/min): Typical: _____ Min: _____ Max: _____

Flocculant Dosage (ppm or mg/l): Typical: _____ Min: _____ Max: _____

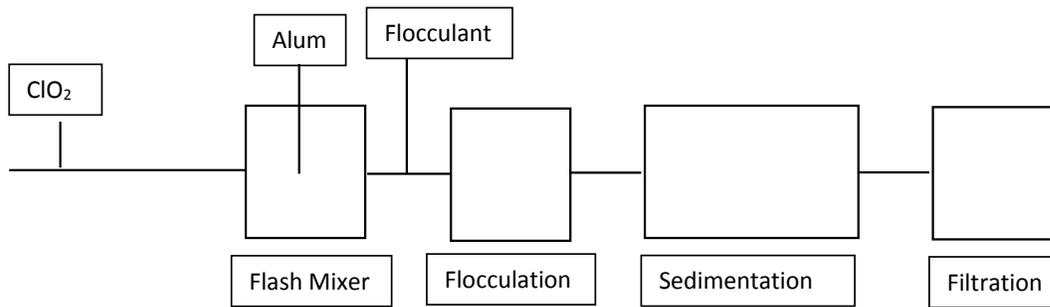
¹ Provide the chemical concentration value that is used in the dosage calculation (e.g. 48% is commonly used for Alum when calculating as dry aluminum sulfate).

² Provide the weight or specific gravity of the chemical.

List all other chemicals (chlorine, caustic, potassium permanganate, filter aids, etc.), that are fed upstream of filtration along with their typical dosage:

Please provide simple plant diagram (hand sketch) that describes the process and shows points of chemical addition.

Example:



Contact Information

Name _____ Title _____

Office Phone _____ Mobile _____

Email _____