Model 432AR
pH/ORP Monitor/Recorder
Manual

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System Configuration

Signal Source	Recorder	Meter
Setpoint A		
Setpoint B		
Setpoint C		
Setpoint D		
Setpoint E		
Setpoint F		
Setpoint controlled by timer		

Description

Model 432 is the combination of a pH recorder and separate pH indicator. It is designed for controlling the pH of waste water, and recording the pH of the neutralized waste fed to a sewer. There are a number of options available, including high/low limit controls and control/alarm for the pH measured by the recorder.

The controller is intended to turn power on or off to a pump or valve whenever the pH of the solution being monitored crosses a set limit. Power outputs are available on the terminal strip at the bottom of the instrument. The set points may be either high or low and are switch selectable on the set point circuit board.

A complete installation consists of electrodes to measure the pH of the solutions, the controller and the neutralization system. The neutralization system consists of a tank to hold the acid or alkaline neutralizer and a valve or pump. This solution will be mixed with material being controlled. The mixing is usually done in a tank or pit with thorough stirring. The first electrode measures the pH of this mixing tank, And the second electrode monitors the pH of the outflow. The instrument is housed in a NEMA-4X enclosure. Mounting lugs are on the rear. Access to the interior is accomplished by loosening the two hasps on the door. All of the controls are on the front panel. Across the top are set point controls. The master power switches above the meter provide power to the meter and the recorder as labeled. These provide power to the amplifiers and to the set points. The fuses adjacent to the master switches are for the amplifiers only. Immediately above the meter are the electrode controls. The temperature and calibration knobs on the right are for the electrode which operates the meter. The temperature and calibration knobs on the left are for the electrode which operates the recorder. The set point knobs establish the pH at which power appears at the output terminals.

Each individual set point control can be adjusted to control either acid or alkali. If a set point controls acid, the panel light will turn on whenever the pH is above the set point and power will be available at the terminals for that set point. If a set point controls alkali, the panel light will turn on whenever the pH is below the set point value and power will be available at the terminals for that set point.

Two set point controls are furnished as standard. 0ne may be used to control the neutralization solution, while the other is used to actuate an alarm. If the solution being controlled will swing both acid or alkaline, two separate neutralization solutions will be added to control the pH within a selected range. As an alternative, the two set point controller can be used to add neutralization solution at two different rates which will provide a degree of proportional control. The latter arrangement is valuable when there are large fluctuations in the amount of material to be neutralized.

Power connections relocated behind the swing out panel at the bottom of the cabinet. The connections are at labeled locations on a terminal block. There are front panel power switches which will interrupt power to the output terminals. This is valuable to disable an alarm or prevent neutralizer feed during cleaning and electrode calibration. The instrument itself consumes 20 watts of 115-volt AC power. It will operate reliably over a range of 100 to 130 volts. The maximum load is 5 amp resistive or a 1/6 HP motor.

Installation

Using the lugs on the rear, mount the instrument on a wall or panel. Bring AC power in through the bottom of the cabinet. Connect power to the three terminals at the right end of the terminal block marked LINE, COM, GND.

In additional to the input power terminals, there are pairs of terminals marked LINE C0M for each set point. The number of pairs will depend on the number of set points installed. Each set point control supplies power to the corresponding LINE, COM terminal. External devices requiring power are connected to the set point LINE and COM terminal.

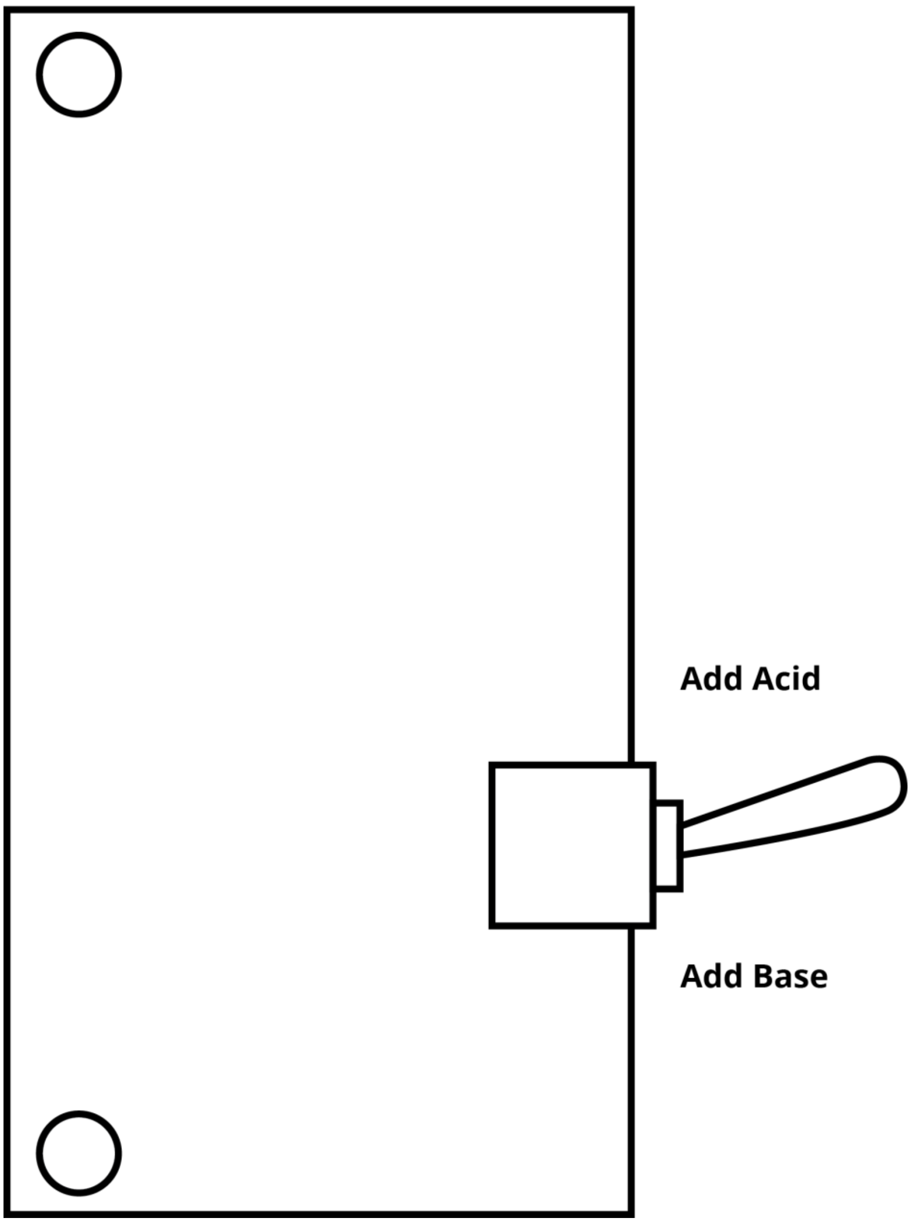
The set point logic has been preset at the factory to provide power output for either acid or alkaline addition. If the need ever arises to change the power output from acid to alkaline or vice versa, it can be done by the following procedure

1. Remove the two thumbscrews at the right of the control panel allowing the panel to open and swing outward.
2. Located directly behind the set point control knob is a circuit board. On the lower side of the circuit board is a toggle switch. Flip this switch to the other side to change the power output. Figure l on the next page shows where the switch should be for acid addition and alkaline addition.

For the indicator-controller, select the optimum point for measuring the solution pH. If a tank is being controlled, the electrode must see sample that is typical of the composition of the entire tank. If a stream is being controlled, the entire stream, or a representative portion of the stream must flow past the electrode. Successful pH control requires adequate mixing of the solution before it reaches the electrode. The addition point for the neutralization solution must be selected to provide such mixing before the solution reaches the electrode. For a tank, it is generally necessary to have a propeller type mixer or a circulation pump. The maximum rate at which neutralization material can be added will depend on the rate of mixing.

Mount the electrode so it will always have the junction for the reference as well as the glass electrode under the solution surface. Excessive neutralization material may be injected if the electrode is out of solution and cannot present the correct signal to the controller.

Set Point Circuit Board



Operation

Make certain all connections are complete for power, pump or valve, and electrode. Start the mixer for the solution be controlled and after a few minutes turn on the instrument. Set the temperature knob to the solution temperature. Set the set point knob to the pH at which the pump or valve should turn on.

When calibrating the electrode, the voltage potentials produced by different electrodes at a pH of 7.00 are slightly different. Consequently, the instrument must be calibrated to the individual electrode by using a buffer solution. The procedure is to dip the electrode into the buffer and adjust calibration knob until the meter reads the pH of the buffer. The electrode should be removed, rinsed and immersed into a second buffer of known value. A new electrode should read 90%of the second buffer value in approximately 5-10 seconds. As electrodes contaminate and age, this response time increases. Electrode response time is an excellent indication of electrode condition. Long response time indicates the need for cleaning, recharging or replacement.

When a new system is first started, it will be necessary to watch the pH meter for several control cycles. The indicator light will show when the relay is on. The purpose of this monitoring is to determine the correct flow rate of the neutralization solution. The flow rate should be adjusted so the pH overshoot on either side of the control point is approximately the same. This will minimize consumption of neutralizer material and produce the most consistent pH for the effluent.

Neutralization solution may be applied by a pump or fed from a tank through a solenoid valve. In either case, it should be possible to regulate the flow, if precise control of the pH is desired. Many different types of metering pumps are available which have adjustable stroke length, period between strokes, or motor speed. If gravity feed is used, a needle valve should be near the solenoid valve to control the flow rate. Adjustable rate solids feeders are available from several manufacturers. If the pump or feed mechanism requires more power than this instrument is capable of handling, a heavy duty electric contactor will be required. A waste treatment system generally consists of a pit with dividers to promote mixing or a series of pits. The first section has a motor driven stirrer and an overflow weir to the next section. This first section must be large enough to hold a several minutes' supply, at maximum rate of flow, of the material to be neutralized. The larger the section the better the pH control. The second section forces the solution under the baffle. The waste then flows out of the third section over another weir and drops into the final compartment or pit. The drain leaves though the wall of this final fourth section. The pH controller monitors the first section and the neutralization material is added there. Regulations require a record of the pH of the waste being discharged to the sewer. The recorder provides this record. The electrode for the recorder should be located close to the point of discharge to the sewer. For some applications, a single, very large, well-stirred pit is adequate for the waste treatment system.

The control system may be tested by using the calibration knobs. 0nce the electrodes are in the solution adjust the set point knobs to approximately the pH of the solution being treated. Slowly turn one of the calibration knobs to swing the pointer of the instrument past the set point. The valve or pump being operated by the controller and the pilot light should turn on and off at the appropriate side of the set point for acid or alkaline addition. It may be desirable to have feed to the control valve or pump turned off these tests. The switches at the set point knob will disconnect power to the terminal strip.

Maintenance

At weekly intervals, the filling solution level in the reference electrode should be checked. If a flow or immersion assembly is being used, the filling solution level need be checked only once a month. If the sample is oily or has a large amount of suspended solids, the glass pH bulb and the junction should be thoroughly wiped with a wet paper towel. Some applications require that the electrode be cleaned with strong acids or caustic solutions. The electrode is designed to resist damage from these materials, but care must be used in using these solutions for cleaning.

Periodically, the temperature of the solution being neutralized should be tested to determine if the temperature compensation knob is set correctly.

If the relay contacts become worn, it should be replaced. The relay is a standard type available from several manufacturers. A replacement unit should have a 12-volt coil with at least 75 ohms resistance. This is available from your dealer. (Or Kruger and Eckels - Part No. 38213)

If the temperature knob is removed, returning it to the shaft requires an electrical calibration procedure. The temperature control knob determines the change in meter reading produced by a change in the input voltage. To set this knob, it will be necessary to have a precise 0.414-volt source. With the instrument input shorted, set the meter to 7.00 with the calibration knob. With +0.414 volts DC injected into the BNC connector, turn the temperature control shaft until the meter reads 0.00 pH. Attach the knob so the pointer indicates 25C.

Electrodes

There are several types of electrodes available for controllers and recorders. A combination electrode is generally ordered with the instrument. A combination electrode has both a glass pH sensitive electrode and a reference electrode in one unit. Separate glass and reference electrodes are for special applications such as high pressure, temperature or unusual chemistries.

The glass pH electrode produces an output voltage potential dependent on the pH of the solution on the outside of the glass bulb. The pH sensitive portion is a thin glass membrane with a spherical surface on the end of the electrode. Inside this bulb is a silver wire coated with silver chloride and a buffer solution. The amount of voltage potential produced depends on the pH and is influenced by temperature. The pH potential is measured across the glass membrane which constitutes a high resistance in the order of 20 to 200 megohms.

Reference Electrode

To complete the electrical circuit to the pH controller, a second electrode is required. The reference electrode contains a neutral salt solution which isolates the wire from solution chemistry. Electrical contact from the reference electrode to the solution is through a junction which will pass a small amount of solution. The junction is either an asbestos fiber, ceramic rod or other porous material. For combination electrodes, this junction appears just above the pH bulb and on the side. For separate reference electrodes, the junction is on the bottom. It is important that this junction be kept clean, otherwise the pH reading will drift. To clean, use a wet paper towel and wipe the junction several times. It may be necessary to acid wash and brush to clean a seriously contaminated reference junction. For accurate readings, the flow must always be out of the electrode and sample should not enter the electrode. Sample entering a reference cell may cause a calibration drift or offset of the pH. If the electrode is calibrated with contaminated filling solution inside, the calibration may cancel out much of the error but it will return if conditions change.

Silver Chloride Reference Electrode

A silver/silver chloride electrode must be kept filled with 4M potassium chloride saturated with silver chloride. Do NOT use filling solution without silver chloride or the electrode will be slowly damaged, as the silver dissolves. There are several reasons for selecting a silver chloride reference. Most types will operate at a high temperature range. If the filling solution is allowed to run out, and the reference cell goes dry, there is generally less problem in re-establishing satisfactory operation when than with others.

Electrode Temperature

The pH calibration of all glass electrodes is dependent on temperature. Therefore, it is necessary to compensate for temperature of the electrode. A Temperature control knob is on the front panel for this compensation. For measurements within one pH of the buffer and between 10C and 40C, the temperature correction error is below 0.1 pH. Consequently, for this type of measurement, the temperature control may be left at 25 C. For measurements at greater than one pH from the buffer and requiring accurate results, the temperature knob must be adjusted. Set this knob to the temperature of the buffer when standardizing the electrode.

For best accuracy, the buffer temperature and the sample temperature must be the same. One method of accomplishing for field work is to immerse the bottle of buffer in the sample solution for a few minutes.

All glass electrodes have a temperature co-efficient proportional to the absolute temperature. The voltage produced by the electrode is greater at higher temperatures. For example, if an electrode is calibrated with buffer at pH 7.00 and a temperature of 25 C, each one pH change will produce an output change of 59 millivolts. At 50 C, each one pH change will produce an electrode output change of 64 millivolts. The meter Temperature knob adjusts the number of millivolts change at the input connector required to make a one pH change on meter. The instrument temperature compensation knob is essentially a slope control or in electronic terms, an amplifier gain control.

Buffer Solution

Buffer solutions for calibrating the electrode are available from your pH meter dealer, or may be prepared from the instructions provided in many chemical handbooks. For best test accuracy, the buffer pH should be as close as possible to the sample pH. Buffer solution pH may change with time due to absorption of carbon dioxide. Solution stored in plastic bottles for more than a year should be suspect and checked against fresh buffer. Deterioration is greatest for high pH buffer, such as borate.

All buffer solutions change pH with a change in temperature.

The pH of buffer solutions available from your dealer is shown below:

Temperature	4.00 pH Buffer	7.00 pH Buffer	10.00 pH Buffer
0	4.00	7.12	10.31
10	4.00	7.06	10.17
15	4.00	7.04	10.11
20	4.00	7.02	10.05
25	4.00	7.00	10.00
30	4.01	6.99	9.95
35	4.02	6.98	9.91
40	4.03	6.97	9.87
50	4.06	6.97	9.81

Sample pH will also change with temperature depending on the composition. For accurate results, it is important that buffer and sample be at the same temperature. Conversely, if an accuracy of only 0.2 pH is required, buffer pH drift with temperature generally may be ignored.

Electrode Calibration

It is essential that the electrodes be periodically calibrated. The frequency will depend on the amount of oil and suspended solids in the water being controlled. Satisfactory electrode performance is dependent on good electrical contact between the electrode and the water. Accumulated deposits on the electrode surface can interfere with response to pH. For a new system at first this should be daily. If it is found the calibration drift is insignificant the period between calibration tests may be extended.

If an electrode becomes severely fouled, it is possible that the response to pH changes will be reduced. It may be possible to calibrate the electrode at one pH (for example 7.00 but not have a correct reading at a pH different from the buffer. To determine whether the electrode pH response is accurate, it is necessary to calibrate the electrode at least at two different pH values. This may be done with two different buffer solutions. Adjust the pointer to the correct value with the electrode in the first buffer, remove the buffer, rinse the electrode with pure water and then dip the electrode in the second buffer of different pH. The pointer should read correctly. If not, clean the electrode. It is important that both the glass pH sensitive bulb and the reference junction be clean. Wipe thoroughly with a wet paper towel. Clean or replace electrode parts until the correct response is obtained. A secondary reason for incorrect response is that the temperature correction knob is out of adjustment. If the knob is set too high a temperature, the change in instrument reading for a change in pH will be less than should occur.

Electrode Cleaning

pH and ORP sensors need periodic cleaning. The cleaning frequency and type of the cleaner will vary with the type of contamination. pH and ORP sensors are constructed to be chemically resistant to strong acids or bases, and a wide variety of cleaners can be used.

Cleaning the pH Electrode

Soap and water will remove oil and grease but will not remove scale or calcification. Hydrochloric acid will remove scale and calcium deposits but it will not remove oil and grease. In order to properly clean an electrode, the nature of the contaminant should be identified, and a proper cleaner found. Soap and water and a small tooth brush will remove many common contaminants. It should be noted that many soaps, commercial cleaners, glass cleaners, contain chemicals that will leave an electrically conductive film on the pH sensor, and interfere with the measurement. When inspecting the electrode for contamination, check the electrode when it is dry. Liquid on the electrode will make the glass or platinum surface glossy and hide scale. Hard water can cause scale on the electrode. Dry patches on a wet electrode may indicate oil or grease contamination.

Cleaning the ORP Electrode

In addition to the above, contamination of an ORP sensor may also be the gradual deposition of ionic metal onto the platinum. This is identified by a slight dulling of the platinum surface, and eventually the appearance of color. This can be removed by polishing with DE or Bon Ami. Use a damp cloth or paper towel and some powder and polish the platinum surface. If there is color on the cloth after cleaning, your treatment system should be checked for ground faults, solution ground and the source of the ionic metal. In selecting a cleaner for the platinum electrode, check the contents to see that there are no oxidizers in the cleaner. If the platinum electrode is cleaned with this type of cleaner the electrode will be polarized during the cleaning and will take some time to discharge. Also check the cleaner to see if it contains highly abrasive materials such as sand, which would scratch the platinum surface.

Cleaning the Reference Junction

Cleaning also includes cleaning the reference junction. This will vary with the style of the electrode design. Sealed non-refillable generally have a ceramic, or other porous material for the reference. The most common reference failure is by clogging. If the obstruction is a potassium chloride crystal, temperature cycling the electrode may make the crystal re-dissolve. If the obstruction is oil, cleaning with alcohol may remove it. If the reference junction is removable, it can be soaked in alcohol to remove the oil contamination or boiled in water to remove a crystal contamination. With some electrode styles the reference material may be lightly sanded to remove any contamination from the outer surface.

Electrode Storage

When pH and ORP electrodes are not in use they should be stored in 3.8 M KCl or saturated KCl. Sometimes the electrodes come with a protective plastic cap on the pH bulb, and this can be filled and used for storage. If the electrodes are stored dry the filling solution will slowly wick out of the electrode. This is not a problem with refillable electrodes, but will reduce the effective lifetime of non-refillable electrodes. Storing the electrode dry will also affect the pH sensitive glass bulb which will dehydrate, and need to be soaked in KCl before being used for measurement.

Do not store pH electrodes in distilled or deionized water, as it will leach out the filling solution. Distilled and deionized water can cause crystals to form inside the reference junction. A good storage solution is 3.8M potassium chloride or saturated potassium chloride. Reorder #81966

Troubleshooting Instrumentation

Isolate the problem to:

1. The instrument
2. The electrode
3. The extension cable

Instrument Checkout

1. Short the input with a shorting strap, shunt or a paper clip. Connect the center conductor to the shell of the BNC.
    a. The instrument should span from pH 0 to 14 when the calibration knob is turned from full left to full right.
    b. Some instruments will have a 10 turn calibration knob and will span from 0 to 14 pH.
    c. If the instrument is offset for antimony electrodes, the span will be below 0 to 4 or 5 pH.
    d. Adjust the calibration knob to read pH 9 and turn the temperature knob from OC to 100C. The reading should change almost a full pH unit
    e. If the pointer doesn't move:
        i. Check the wires to the meter for a short or a loose connection.
        ii. If possible, move the instrument to see if the pointer will move. If the pointer is stuck, remove the meter and remove the cover. Carefully check and remove the obstruction. The meter zero adjust may have been broken and jammed the movement; the mechanical zero adjust is not necessary in most pH measurements.
    f. If the meter drifts, is erratic or is full upscale or downscale with the BNC shorted, the electronics may need service. Consult your dealer or the factory.
2. Set the indicator to pH 7 with the calibration knob.
    a. Rotate the set point knob through the indicator value. There should be relay actuation and the lamp should go on or off. Power at the output terminals should also go on or off.
    b. On some instruments the set point lamp will go on only above the set point. In these instruments there are separate output connections for alkaline and acid feeders.
    c. Newer instruments have a switch on the set point circuit board to select for above or below setpoint operation. These controllers have outputs labeled line and common.
    d. Some instruments are wired for a contact closure only. These will show an open or closed measurement with an ohmmeter.
    e. Series wired set points (Inter-wired set points)
        i. In this case a second set point will also have an effect on set point output. The most common case is that the first set point has to be on and the over-range safety set point has to be on.

    ii. With the first set point on, rotate the second set point to see if it will control the output. Generally, the second set point will interrupt feed if the pH goes above the second set point.

Electrode Checkout

1. Plug the electrode directly into the instrument.
2. Rinse the electrode with distilled water; some meter movement is normal during washing.
3. Put the electrode into pH 7 buffer solution, allow the electrode to stabilize and adjust the calibration knob to make the instrument read 7.00.
4. Remove the electrode, rinse, and put the electrode into pH 4.01 buffer. The electrode should read the buffer value in the first few minutes. Repeat the above with pH 10.00 buffer.
    a. If the electrode will not produce a reading:
        i. The electrode is shorted and needs to be replaced.
        ii. The reference solution is contaminated or gone and needs to be replaced.
    b. If the electrode will not read the buffer values and/or is slow in response:
        i. The pH bulb is contaminated and needs to be cleaned. A fingerprint is enough to cause incorrect readings.
        ii. The reference junction is clogged or the reference solution is contaminated.
            1. Sealed electrodes can temperature-cycled in a 2 molar KC1 solution which may clear the obstruction.
            2. Refillable electrodes can be recharged and the reference junction can be replaced. Consult the dealer or manufacturer.
        iii. Compressed response is an indication that the electrode is aging or needs service. As a temporary measure the temperature knob can be used to amplify the electrode output, or the slope control can be used for compensation.

Extension Cables and Electrode Installation

1. Extension cable failure
    a. The BNC shell has become grounded. There should be more than 100 megohms between the BNC shell and instrument and solution ground.
    b. The cable is shorted
        i. There should be more than 100 megohms between the center conductor and the shell of the BNC connector. If a high resistance short is found, it may be caused by moisture in the BNC. Clean with alcohol and retest.
        ii. A low resistance short is caused by the shield coming in contact with the center conductor of the cable. In this case replace the cable.
    c. The cable is open and should be replaced.
        i. There should be continuity between the shell at one end and the shell at the other.
        ii. There should be continuity between the center contacts at both ends of the cable.
2. Electrode Installation

a. The electrode should be deep enough into the solution so that both the reference and the glass bulb are submerged.
b. The electrode should be close to vertical with the pH bulb down.
c. The BNC connector should be insulated from any electrical ground potential.
d. In some installations the sample solution will have to be grounded in order to have accurate readings, and normal electrode life.

Other Failure Conditions

1. The instrument reacts when a solenoid or valve turns on or off.
    a. Improper grounding of the instrument or solution.
    b. Low voltage to the instrument, causing the instrument to fall out of regulation.
2. pH measurements are not stable or controller is unable to stabilize the sample.
    a. Insufficient mixing of the sample.
    b. The electrode and the neutralizer feeder are too close together or too far apart.
3. Instrument calling for feed and no indication of pH Change.
    a. Lack of neutralizer in the supply tank.
    b. Failure of the feed solenoid to open; frozen or jammed.
    c. Lack of agitation in the neutralization tank, or loss of sample flow past the electrode.
    d. Fuse blown at the instrument, and no voltage to the feeder.
    e. Override switch on the instrument in the off position.
4. Instrument not calling for feed and pH changing.
    a. Solenoid or valve stuck in the open position.
    b. Instrument relay stuck in the on position.
5. Instrument calibrates correctly in buffers but will not read pH correctly in the sample.
    a. The BNC has become grounded in the electrode system.

Warranty

A 30-day trial period is offered by Kruger & Eckels, Inc. should any of our instruments prove unsatisfactory, for any reason, within 30 days of receipt; just return the unit to us at no obligation to you.

To take advantage of this offer, issue an order number for us to ship against, and we will ship and bill net 30 days. Should you decide to return the unit within 30 days, we will cancel the invoice and refund payment.

Kruger & Eckels, Inc. warrants all of its electronic instrumentation for two years against defects in material or workmanship. This warranty does not apply to mechanical meters, recorders or electrodes, which are covered by separate warranties by their own manufacturers. Should a failure occur, the unit will be repaired at no charge to the customer.

Mechanical meters and recorders are warranted for one year, and electrodes are warranted for six months. This warranty covers normal use and does not cover damage which occurs in shipping or failure which results from accident, abuse, improper installation, improper maintenance, or using the device in a manner which is not recommended by Kruger & Eckels.

Replacement Parts

Part Name	Part Number
Replacement meter	35521
Replacement recorder	35700
Pilot light screw base	37510A
Shorting strap	38315
Replacement relay	38213
Chart paper 0-14 pH scale (30 day)	47513
¼ amp fuses (Box of 5)	38504
5 amp fuses (Box of 5)	38501

Industrial Controller Power Wiring