

INSTRUCTION MANUAL

MODEL 130

DIGITAL ACID ETCHANT CONTROL/MONITOR

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TABLE OF CONTENTS

1. INTRODUCTION.....	1
1.1 Description.....	1
1.2 Principle of Operation.....	1
1.3 Performance Capability.....	2
2. OPERATING INSTRUCTIONS.....	2
2.1 Switch Operation.....	2
2.2 Indicators.....	3
2.3 Alarm.....	3
3. INSTALLATION.....	3
3.0 Locations.....	3
3.1 Etchant Control.....	4
3.1.1 Mounting.....	4
3.1.2 Plumbing Connections.....	4
3.1.3 Optical Encoder Adjustment.....	5
3.2 Power Module.....	5
3.2.1 Mounting.....	5
3.2.2 Electrical Connections.....	5
3.3 Etchant Monitor.....	6
3.4 Installation Checkout.....	6
4. SERVICE PROCEDURES.....	7
4.1 Control Point Adjustment.....	7
4.2 Encoder Alignment Procedure.....	7
4.3 Control Point Alarm Tolerance Adjustment.....	8
4.4 Routine Maintenance.....	8
4.5 Trouble Shooting.....	8
4.5.1 No Power.....	8
4.5.2 Mechanical Operation.....	9
4.5.3 Electronic Parts.....	9
4.5.3.1 Power Module Boards.....	9
4.5.3.2 Control Circuit.....	10
4.5.3.3 Monitor.....	10
5. PROCESS CONTROL.....	11
5.1 Monitor Indicators.....	11

1. INTRODUCTION

1.1 Description

The Model 130 Digital Etchant Control/Monitor consists of three pieces: the Model 132 Etchant Monitor, the Model 124 Etchant Control and the Model 120 Power Module. The Control unit contains a hydrometer sensitive to etchant specific gravity. Electronics in the control read hydrometer position, encode the information and transmit it to the Monitor. The Monitor displays the measured Baume deviation from the set control point, makes control decisions to maintain etchant within about +0.1 degree Baume of the desired control point, and sets off visual and audible alarms if the etchant density deviates more than the user set tolerance from the set control point. The Power Module has system low voltage power supplies and the replenisher pump control power relay.

Plug-in cables about 12 feet long are provided to connect the Monitor to the Control and Monitor to Power Module.

1.2 Principle of Operation

The Control consists of two compartments, wet and dry. The wet compartment contains a hydrometer which responds to etchant density. Hydrometer motion is transmitted by a pivoted beam thru a isolating elastomeric diaphragm into the dry compartment. Optical sensors in the dry side detect pivot beam position and thus hydrometer position, frictionlessly. The optical position sensor is an optical encoder which passes between light emitting diode-phototransistor pairs to cut the infrared optical beams passing between them.

During operation the etchant continuously flows into the bottom of the wet inner chamber, over the dam and out the wet chamber drain. An eighth inch drain hole at the bottom of the dam allows the inner chamber to drain when the etchant supply turns off. The gas bubbles in the solution leave the wet chamber thru a vent pipe on the bottom of the Control unit. The encoder can measure deviations as much as +1.9 degrees Baume from the control point. The encoder hydrometer deviation information is sent to the Monitor unit.

The Monitor displays the resulting Baume deviation value for the etchant. If the deviation exceeds 1.9 the display numbers go blank. When the etchant density stays above the control point for a few seconds the replenishment pump is turned on and continues to run until the etchant density returns to the control point. The delay in pump turn on minimizes relay and pump wear due to excessively rapid cycling. Pump lights on Monitor and Power Module inform the operator when power is delivered to the pump terminal.

The Monitor has an adjustable Baume tolerance which can be set from 0.0 to 0.9 in 0.1 increments. The factory setting is 0.3. The Monitor alarm sounds and the display numbers flash if the magnitude of the displayed value exceeds the set tolerance. The plus or minus sign on the numerical display will tell whether the deviation is above or below the control point. If the replenishment pump has turned on to correct the out of tolerance situation the alarm will wait 5 minutes before it sounds to give the system a chance to correct automatically. The alarm also sounds if the pump runs continuously more than 5 minutes. The operator can silence the alarm for 5 minutes while the situation is worked on.

1.3 Performance Capability

The Model 130 Etchant Control/Monitor will hold the density of the etchant in its measuring chamber within ± 0.1 degrees Baume of the set control point if the etcher replenishment feed pump and sump mixing are adequate to keep up with the work load.

2. OPERATING INSTRUCTIONS

2.1 Switch Operation

The switch on the Power Module has three positions: MANUAL, OFF and AUTO. In the OFF position power to the Control, Monitor, and replenisher pump(s) is off. In the MANUAL position the replenisher pump(s) run continuously without any control if the power source to the Power Module is energized. In the AUTO position the automatic control part of the Etchant Control/Monitor is activated and the replenisher pump(s) will be turned on and off as needed to maintain the specific gravity of the etchant solution at the desired set point.

There are two different installation wiring situations to be considered: Case I and Case II. In Case I the power source to the Power Module is energized only when solution is being fed to the Etchant Control and the switch can be left in the AUTO position all the time. In Case II the installation wiring allows the Power Module to be energized when solution is not being fed to the Etchant Control. In Case II when the etcher is not etching the Control will sense that the hydrometer float is on the bottom of the inner chamber, interpret this as low density, and turn on the alarm. To prevent this false alarming in Case II turn the Power Module switch OFF when solution is not being fed to the Etchant Control. Turning the power off also avoids all the inherent hazards of leaving any equipment powered and unattended.

2.2 Indicators

The PUMP lights on the Power Module and Monitor turn on whenever the replenisher pump(s) are energized whether by the MANUAL switch position or by the control relay in the AUTO switch position. The AUTO lights on the Power Module and Monitor indicate that the AUTO switch is on. The Baume display gives etchant density deviation from the process control point in a range ± 1.9 degrees. The displayed numbers blink if the density is outside the set tolerance. The digital display is blanked if there is no solution in the float chamber or if the density cannot be determined accurately because it is more than 1.9 degrees away from the control point. A blanked display and PLUS SIGN indication means that the solution density is more than 1.9 degrees above the set point. A blanked display with MINUS SIGN indication means either

that the solution chamber is not full or that the solution density is beyond 1.9 degrees below the control point.

2.3 Alarm

The alarm sounds immediately if the tolerance limit is exceeded or replenisher pump(s) run continuously for more than five minutes. If the solution is out of tolerance but the replenisher pump(s) are running, the control waits five minutes to give the system a chance to correct itself automatically before sounding the alarm. The operator can silence the alarm for a five minute interval by pressing the ALARM CANCEL button on the Monitor. The alarm is automatically silenced at power up for 5 minutes or until the plus sign comes on to allow time for the solution chamber to fill at start up.

3. INSTALLATION

3.0 Locations

The Control and Power Module are connected to the Monitor unit by cables about 12 feet long. Extension cables are available as an option. The Monitor must be where the operator can see, hear and touch it. The Power Module must be accessible enough to allow switch operation and fuse replacement. The Etchant Control must be securely mounted to a vertical surface with the drain in the bottom high enough above the etcher sump to allow proper drainage. The top of the Control must be level.

3.1 Etchant Control

3.1.1 Mounting

Mount the Etchant Control securely to a vertical surface using corrosion resistant bolts thru the mounting flanges on the sides of the unit. Four quarter inch flange holes are provided. Shim between the mounting flanges and "vertical" surface as required to give a secure mount and make the top of the Etchant Control level. Remove the covers and carefully take the packaging material out from around the dry chamber pivots and from the float in the inner wet chamber. Replace the left cover to prevent etchant droplets from settling on the circuit board in the dry chamber.

3.1.2 Plumbing Connections

Use quarter inch high pressure plastic tubing to connect between the etch machine spray manifold and the Etchant Control inlet at the bottom of the inner chamber. Make sure connections are secure and tube routing will not be subject to damage or cause hazard. Use three-quarter inch plastic drain hose to connect the drain on the bottom of the Etchant Control to the etcher sump. Make sure the drain hose routing always slopes away from the Control and does not cause a hazard. If the drain hose is allowed to sag so that the etchant must flow uphill in some section, then a trap is formed which can become plugged. Clamp and support the drain hose securely so that it cannot become plugged at an accidental trap.

Turn on the etcher spray pump and observe the time required to fill the inner chamber to overflowing. If it is less than 20 seconds reduce the flow by increasing the length of quarter inch tubing used. If the fill time is over two minutes then increase the flow by shortening the tubing used, changing the tap location on the etcher, or by using appropriate adapters and a larger diameter high pressure tubing. Carefully observe all plumbing connections and correct any leaks found. Turn the etcher off.

The vent pipe on the bottom of the Etchant Control releases the gas from the bubbles in the solution entering the Control. The vent can ordinarily simply vent to the room air, but if desired it can be indirectly connected to the etcher venting system. Do not simply run a closed tube from the Control vent to the vent vacuum. The vacuum created in the Control could distort the elastomeric diaphragm and cause problems. Indirect venting in which a tube connected to the vent vacuum draws room air past the open end of the vent pipe can be used.

3.1.3 Optical Encoder Adjustment

Replace the right cover, remove the left cover and turn on the etcher spray pump. With etchant in the solution chamber press down on the beam to make the encoder pass through the slot in the circuit board. Check to make sure the encoder is vertical, approximately centered in the slot, and swings freely without rubbing on anything. If the encoder is not vertical, loosen the encoder set screw which fastens the encoder bracket to the beam, twist the encoder to vertical, and tighten the set screw. Do NOT loosen the bottom screw which clamps the encoder to the encoder bracket. If the bottom screw is loosened the encoder alignment procedure in Section 4.2 must be performed. The position of the encoder in the circuit board slot can be adjusted if necessary by loosening the screws which hold the circuit board. Position the board and retighten the screws. Turn the etcher spray pump off.

3.2 Power Module

3.2.1 Mounting

Loosen the four cover screws and remove the Power Module cover. There is a mounting hole at each corner of the Power Module. Use screws through these mounting holes to secure the Power Module to any suitable vertical or horizontal surface.

3.2.2 Electrical Connections

Look at the voltage written on the main circuit board in the Power Module to verify that it matches the line voltage (either 120 or 230 volts, 50 or 60 Hz) which you intend to use.

A 7/8 inch diameter hole is provided for 1/2 inch conduit or a standard cable clamp. Turn the Power Module switch OFF. Turn off the power source you intend to use. The power AC connections are to the 8 position terminal strip near the 7/8 inch hole. Connect the P, N, and G terminals to the replenisher pump(s)' Power Neutral and Ground connections respectively. If a solder conditioner/brightener solution replenisher pump is also connected to the P, N, and G terminals then conditioner solution replenishment can also be automatically controlled. Connect terminal L to the AC power source line. If possible create the more convenient and efficient Case I in Section 2.1 by connecting L to an AC power source which goes on and off with the etcher's main etch pump. This power can be tapped directly off the line that supplies the etch spray pump if the voltage is correct and the line current is less than 50 amps. Line currents over 50 amps may cause the Power Module fuse to blow occasionally from the inductive kick when the spray pump turns off. Connect the power source Neutral to N and non-current carrying Ground to a G terminal. If sealed conduit is not used for AC leads then the hole they come through into the Power Module should be sealed with silicone RTV to keep out moisture and corrosive fumes.

Turn on the AC power source and with a suitable test instrument verify that the L, N, and G connections are correct. Flip the Power Module switch to MANUAL and verify that the replenisher pump(s) run. Turn the Power Module switch OFF and the AC power source off. Replace the Power Module cover correctly oriented to the indicator lights and tighten the cover screws.

3.3 Etchant Monitor

Plug the cable from the Etchant Control into the Etchant Monitor. Set the Monitor where it faces the operator and can be reached to actuate the ALARM CANCEL button. Loop any excess length of the cable around the cable windes on the bottom of the Control and wire tie them to the holes provided. Two wire ties are conveniently taped to the bottom of the Control for this purpose. Plug the 5 conductor cable with the circular plastic connector into the Power Module.

3.4 Installation Checkout

Set the Power Module switch to AUTO and turn on the etcher spray pump. If the starting etchant density is above the control point the replenisher pump(s) will run until the Etchant Controller is satisfied. When the controller turns off the replenisher pump(s) the etchant density in the sump can be measured with an accurate, expanded scale hydrometer. The hydrometer should read between 20 and 30 degrees Baume with 0.1 degree resolution. The density thus measured is the controller's control point. If the starting density is below the control point then some work will have to be fed thru the etcher until the replenisher pump(s) begin to cycle on and off. The control point of a virgin controller will drift up about 1 degree Baume during the first few hours of use as the plastic surface of the float cures in the etchant and fewer bubbles cling to it. After curing the control point stabilizes and the performance outlined in Section 1.3 will be obtained. The stabilized control point as shipped from the factory is approximately 25.7 degrees Baume. To change the control point see Section 4.1.

Replace all covers that are off and tighten cover screws.

4. SERVICE PROCEDURES

4.1 Control Point Adjustment

Remove the left (dry) compartment cover of the Etchant Control. The PVC weight between the optical encoder and the pivot assembly is used to adjust the set point. Moving the weight one inch toward the optical encoder lowers the set point about 3 degrees Baume. To move the weight loosen its set screw, slide the weight to the desired place, and tighten the screw. An auxiliary PVC weight has been provided which can be added to either the dry or wet side of the beam to increase the adjustment range. Replace any covers that have been removed.

4.2 Encoder Alignment Procedure

There are two set screws which determine the position of the encoder. The top screw controls position and twist upon the beam. The bottom screw controls tilt for proper counting. Loosen the top set screw and adjust the encoder mounting bracket to make the encoder card vertical as it swings through the slot in circuit board 124-1. Make sure the encoder does not rub against the edges of the slot. Move the bracket until the outside row of stripes (narrowest stripes) runs between the outside sensor pair (left end). Tighten the set screw but don't overtighten.

With the unit powered swing the beam and observe the Baume numbers displayed. If it counts properly in sequence up and down, no further adjustment is needed. If there are missing or out of sequence numbers displayed as the beam is moved then the tilt of the encoder needs adjusting with the following procedure:

- 1) With the float at the bottom of its travel look directly down along the optical card's edge checking to see that the card is centered through the slot in the 124-1 board. The set screw on top of the card mounting bracket allows the card to be moved along the beam or twisted about it. Center the card in the slot making sure it is vertical. The card should not wander front to back in the slot as the beam is moved up and down.
- 2) The front to back position of the slot can be adjusted by loosening the two 124-1 circuit board mounting screws along the back edge of the board. The board can be repositioned to center the optical card in the slot front to back. Once the card is centered with the float at its lowest position, tighten the board mounting screws.
- 3) Gently raise and lower the float to make sure the card swings vertically and does not drag against the circuit board.
- 4) To adjust the tilt on the optical card toward or away from the pivots, loosen the clamping screw at the bottom edge of the card. Raise the float and tilt the card until the edge of the left most dark stripe aligns with the silver arrow on the circuit board. For proper alignment this arrow should continuously point to the strip's edge as it passes by when the float is lowered.

5) Power up the unit and raise and lower the float. The displayed value should increase smoothly from -1.9 to +1.9 with no missing numbers as the float is raised. Look for missing numbers and reverse counting in which the displayed number changes the wrong direction as the float is moved. If the display does not count properly, the card tilt needs to be adjusted slightly. If there are missing counts try tilting the card slightly to the right. If the count seems sluggish and the display fails to count as far as it should before blanking, try tilting the card slightly to the left. Tilting slightly too far to the left makes the - count range bad; tilting slightly too far to the right makes the + count range bad.

4.3 Control Point Alarm Tolerance Adjustment

The maximum Baume deviation number which can be displayed without setting off the alarm is the tolerance value. As shipped from the factory it is set at 0.3 which is an appropriate value for most situations with etchers in good condition. However if a particular etcher is unable to keep the solution to this precision it will be necessary to adjust the tolerance setting switch inside the monitor to prevent excessive alarming. After the etcher is running as well as it can, observe the variation in the Baume deviation display and note the largest positive or negative number in normal operation. This number is the tolerance needed to avoid alarming in normal operation. Remove the four faceplate mounting screws from the monitor front and gently pull the monitor circuit out of the case. On the back of the circuit board is a rotary 10 position switch marked 0 to 9 which sets the alarm tolerance to any desired value from .0 to .9 degrees Baume. Use a small screwdriver to set the switch to the desired number. Replace the faceplate and reinstall the faceplate mounting screws.

4.4 Routine Maintenance

The unit requires no routine maintenance. However, if the etchant is allowed to sludge in the etch machine sump then excessive sludge may also accumulate in the Etchant Control wet chamber. In that event the Etchant Control wet chamber must be cleaned. Sludge can stick to the bottom of the float causing the control point to increase. It also can glue the float to the bottom of the wet chamber preventing the control from working at all. If excessive sludge has accumulated in the wet chamber then be sure the 1/8 inch drain hole in the bottom of the dam is clear. The hole is at the bottom of the dam near the 3/4 inch drain.

4.5 Trouble Shooting

4.5.1 No Power

If none of the indicator lights light and the replenisher pump(s) don't run in MANUAL then check the 5 amp slow blow fuse, the power source to the Power Module and the wiring connections. If the fuse is blown it must be replaced with a fuse no larger than a 5 amp slow blow.

4.5.2 Mechanical Operation

The beam should pivot freely when the hydrometer is floating in the etchant filled solution chamber. If you raise or lower the beam slightly to decrease or increase the displayed Baume deviation a few tenths, the reading should return to within 0.1 degree of the initial displayed value when you release the beam. If the beam does not move freely check the adjustment of the optical encoder to make sure it is not rubbing on something.

4.5.3 Electronic Parts

There are five circuit boards in the system identified by numbers 120-1, 120-2, and 120-3 in the Power Module; 124-1 in the Control unit; and 132-1 in the Monitor.

4.5.3.1 Power Module Boards

Board 120-1 is the large mother board in the bottom of the Power Module box. It has the transformer, surge suppressors, and interconnections for boards 120-2 and 120-3. Board 120-2 has the LED's and the + and - 12 VDC power supplies. With the system powered there should be 10 VAC on the right ends of the two diodes just below the red LED. Be careful making measurements on any of the Power Module boards since they all have full power line voltage at some points on them.

Board 120-2 is ok if with Control and Monitor connected:

1. There is + 12 to + 14 VDC on the yellow lead into the AMP connector on the Power Module,
2. There is - 12 to -14 VDC on the white/red lead,
3. The green LED lights in the AUTO mode,
4. The red LED lights whenever the pump is powered,
5. The white/blue lead is less than 0.5 VDC when the AUTO light is on and over 2 VDC when the AUTO light is off and the PUMP light is on, and
6. The gray lead is less than 0.5 VDC when the PUMP light is on and over 2 VDC when the PUMP light is off and AUTO light is on.

Board 120-3 has the power relay to switch line power to the replenisher pump(s). Board 120-3 is ok if in the AUTO mode the pumps are powered when the orange lead at the AMP connector is over 2 VDC and the pumps are off when the orange lead is under 1 VDC. There should be a 2 to 3 second delay between the time the voltage on the orange lead starts to rise and the relay switches. A quick relay test in AUTO when the pump is off is to unplug the Power Module cable at the AMP connector; the relay should pull in and the PUMP light on the Power Module come on after a 2 to 3 second delay.

4.5.3.2 Control Circuit

The signals on the Control Circuit cable can be measured on the Monitor circuit board or at the Control by scraping thru the protective coating. The signals on each wire are as follows:

BLACK	+12 volts power from the Power Module passing thru the Monitor
GREEN	ground from the Power Module thru the Monitor
BROWN	K signal low (<0.5 volts) indicates that the encoder is beyond the end of its valid counting range and the display should be blanked; if high (>2.0 volts) the display should show a number
BLUE	LOW adds 0.1 to displayed number
ORANGE	LOW adds 0.2 to displayed number
YELLOW	LOW adds 0.4 to displayed number
RED	LOW adds 0.8 to displayed number
VIOLET	LOW adds 1.0 to displayed number
WHITE	Pump Control and Sign: if >1.4 volts the + sign is displayed and the pump is on; if <0.5 the - sign is displayed and the pump is off

For example, if BROWN is high, WHITE is low, BLUE ORANGE and VIOLET are low, and YELLOW and RED are high; the display should show $-(0.1+0.2+1.0) = -1.3$.

The signals on the lines can be measured with a DC voltmeter to check for correct Control Circuit performance after the optical encoder is aligned with the procedure in Section 4.2.

4.5.3.3 Monitor

If the Power Module and Control are supplying proper signals to the Monitor and it is not functioning correctly, replace the unit. There are no user replaceable circuit boards inside the Monitor case.

5. PROCESS CONTROL

5.1 Monitor Indicators

The monitor functions can be very useful in detecting and correcting many etcher situations which can cause quality and yield problems. Table 5.1 summarizes these functions and what they tell about the etching process.

Table 5.1 Process monitor functions

AUTO PUMP + - ALARM SITUATION DETECTED AND possible corrective actions

on				NORMAL OPERATION, ETCHANT DENSITY IN BALANCE no action required
on	on			NORMAL REPLENISHER FEED no action required
on	on		on	INSUFFICIENT REPLENISHER REACHING SUMP AND PUMP HAS RUN MORE THAN 5 MIN. CONTINUOUSLY check replenisher supply, plumbing, pump, pump size
on	on	on	on	INSUFFICIENT REPLENISHER REACHING SUMP, PUMP HAS RUN 5 MIN. AND DENSITY DEVIATION IS POSITIVE AND ABOVE TOLERANCE check replenisher supply, plumbing, pump, pump size
on		on	on	DENSITY ABOVE SET POINT BUT PUMP NOT POWERED check pump relay
on		on	on	LOW DENSITY BELOW SET POINT DUE TO: NO OR LOW SOLUTION IN CONTROL cancel alarm and wait for control tank to fill or if that doesn't work check etchant connection to control ETCHER SUMP HAS BEEN OVER REPLENISHED check for excessive manual operation check for possible replenisher syphoning and if found install a check valve or a syphon vacuum break WATER INTRUSION INTO ETCHER check for leaks, rinse spray being drawn into etchant, or excessive water on parts being fed in LARGE AMOUNT OF AMMONIUM HYDROXIDE ADDED TO SUMP correct excessive ammonia loss or use anhydrous ETCHANT CONTROLLER TURNED ON DURING HEAT-UP PROCESS instruct operator
	on			MANUAL MODE OF OPERATION none
	on		on	MANUAL OPERATION FOR OVER 5 MIN. instruct operator

LIMITED WARRANTY

Optrol Inc. warrants this Model 130 Etchant Control/Monitor to be free of defects in material or workmanship for a period of two years from the date of shipment. In the event of such defect Optrol will at its option repair or replace free of charge any defective part which is returned, shipping prepaid, to the Optrol factory. This warranty does not apply to damage caused by misuse, neglect, accident, modification, or failure to follow instructions provided with the product. Any product repaired or replaced under warranty will itself be warranted only for the remaining portion of the original warranty.

Except as provided herein, Optrol makes no warranties, express or implied, including warranties of merchantability and fitness for a particular purpose.

In no event shall Optrol be liable for any incidental, consequential, special, indirect, punitive, or exemplary damages or lost profits from any breach of warranty or otherwise.

This warranty gives the purchaser specific rights, state laws may give other rights which vary from state to state. This written warranty is the final, complete and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of Optrol Inc.