POLLUTION PREVENTION

ATMOSPHERIC EVAPORATIVE RECOVERY APPLIED TO A NICKEL PLATING OPERATION

POLLUTION PREVENTION PROGRAM

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT, HEALTH, AND NATURAL RESOURCES

James G. Martin
Governor

William W. Cobey, Jr.
Secretary, EHNR

FEASIBILITY STUDY OF AN ATMOSPHERIC EVAPORATIVE RECOVERY APPLICATION TO A NICKEL PLATING OPERATION

BRIAN E. WELLS
PLANT ENGINEER

AUGUST 20, 1987

PREPARED FOR
DEPARTMENT OF NATURAL RESOURCES
AND COMMUNITY DEVELOPMENT
RALEIGH, NORTH CAROLINA
UNDER CONTRACT C-1615

ILCO UNICAN CORP.
400 JEFFRIES ROAD
ROCKY MOUNT, NORTH CAROLINA 27801

THE POLLUTION PREVENTION PROGRAM

The Pollution Prevention Program provides free technical assistance to North Carolina industries and municipalities on ways to reduce, recycle and prevent wastes before they become pollutants. This non-regulatory program addresses water and air quality, toxic materials, and solid and hazardous waste. Designated as the lead agency in waste reduction, the Program works in cooperation with the Solid Waste Management Division and the Governor's Waste Management Board. The services and assistance available fall into the following categories:

Information Clearinghouse An information data base provides access to literature sources, contacts, and case studies on waste reduction techniques for specific industries or waste streams. Information is also available through customized computer literature searches. Waste reduction reports published by the Program are also available.

Specific Information Packages. The staff can prepare facility or waste-stream-specific waste reduction reports for industries and communities. Information provided by the facility is used to identify cost-effective waste reduction options. A short report detailing these options is provided along with references, case studies, and contacts.

On-site Technical Assistance. The staff can provide comprehensive technical assistance through facility visits. During an on-site visit, detailed process and waste stream information is collected. The information is analyzed, and a series of waste reduction options are identified. A report is prepared detailing these options and includes literature, contacts, case studies, and vendor information.

Outreach. The staff can give presentations on pollution prevention to industries, trade associations, professional organizations, and citizen groups. Depending on the audience, these programs range from an overview of the State's Pollution Prevention Program to in-depth discussions of technologies for specific industries.

Challenge Grants. A matching grant program provides finds for the cost of personnel, materials, or consultants needed to undertake pollution prevention projects. Projects eligible for grant funds range from characterizing waste streams in order to identify pollution reduction techniques to conducting in-plant and pilot-scale studies of reduction technologies.

For information or technical assistance contact:

Pollution Prevention Program
N.C. Department of Environment, Health, and Natural Resources
Post Office Box 27687
Raleigh, North Carolina 27611-7687

Telephone: (919) 571-4100

ACKNOWLEDGEMENTS

We gratefully acknowledge the Department of Natural Resources and Community Development, for providing Ilco Unican Corp. the opportunity to perform this feasibility study.

I would personally like to thank David Ellis for his technical assistance in test preparation, test operations, and data collection.

Tom Maude, Dick Kriesel and their respective staff assisted in providing high quality engineering and maintenance services to the program.

Also, Paul Singelyn, Vice President of Techmatic, Inc., Nashville, Tennessee, manufacturers of the MAX-EVAP T.M. Atmospheric Evaporator for his guidance during installation and technical assistance provided.

TABLE OF CONTENTS

INTRODUCTION

Ilco Unican Corp., the world's largest key blank and security product manufacturer operates a plant in Rocky Mount, North Carolina. The facility in Rocky Mount primarily produces key blanks. Approximately 80% of the key blanks produced are nickel plated. The nickel plating process like many other plating processes produce rinse waters containing inorganics which are hazardous wastes under current EPA regulations.

In recent years Ilco Unican Corp. has processed the rinse waters by several methods. The most recent method has been neutralization by adjusting the pH, clarification by floculation, settling, filtration and compaction of the sludge generated, and then disposal of the sludge to a hazardous waste landfill. Considerable costs and liability are incurred using this method.

Ilco Unican Corp. presently nickel plates approximately 800,000 keys daily. The pretreated rinse waters generate approximately 12,500 pounds of compacted sludge every 90 days. Although the pretreatment system is virtually automated, considerable labor costs are incurred in handling the sludge. The filter press requires dumping two times weekly. Approximately six man-hours are required to make each dump. The annual labor costs including overhead is estimated at $14,480.00. A monthly roll-off container is rented to hold the sludge at a cost of $3,000.00 annually. Transportation of the container to the landfill in 1986 was $3,351.00, and disposal cost $4,300.00.

SUMMARY

A process feasibility study was successfully performed on an Atmospheric Evaporator System for the Department of Natural Resources. The study was made to determine the feasibility of a closed-loop rinse system on an electroplating line. Atmospheric evaporation is a process that converts liquid into a vapor and is discharged to the atmosphere.

Results indicate that an atmospheric evaporator system successfully reduced head-space in the electroplating tanks sufficient to provide use of the rinse water to replace the evaporated water. Reuse of the rinse water effectively contained constituents of the electroplating bath that are normally discharged to the pretreatment system and subsequently disposed. These favorable results indicate that an adequately designed low-cost atmospheric evaporator system could be utilized to close the loop. The closed loop would eliminate any pretreatment of rinse water and disposal of sludge. Also recovery of the valuable constituents is achieved.

process to both close-the-loop and recover all constituents of the electroplating normally disposed.

A study performed by North Carolina State University (Reference 1) in 1984, based on a total of 115,910 pounds/year indicated the approximate value of the metal was $9,220.00. Since this study Ilco Unican Corp. has reduced the amount of sludge generated annually through waste minimization efforts by decreasing the percent of water. Based on the 1983-84 approximate dollar value of metal, approximately $4,000.00 annually of metals are discarded.

When you add this all up, $29,131.00 annually is either spent or destined in handling the sludge. This does not take into consideration liability associated with the waste and compliance costs associated with the EPA regulations. As EPA regulations become more stringent with regards to landfilling hazardous waste, EPA required waste minimization programs and the costs associated with hazardous waste, Ilco Unican Corp. must attempt to research all feasible recovery means.

Electrodialysis and Electrolytic Recovery are certainly means that can be used. However, both systems are very expensive and maintenance costs are high. The objective of this study was to demonstrate the feasbility of applying an Atmospheric Evaporation System to Ilco Unican's specific electroplating operation, a method that was virtually maintenance free, inexpensive, and a system that could close-the-loop and recover the costly chemicals presently discarded. The evaluation of test results has successfully indicated feasibility of the

North Carolina State University
School of Engineering

Department of Nuclear Engineering
Box 5636 Zip 27650

March 15, 1984

Mr. Brian Wells, Plant Engineer
ILCO UNICAN
400 Fawn Drive
Rocky Mount, NC 27801

Dear Mr. Wells:

Please ignore the first letter of this nature which we sent to you last week. Due to a misunderstanding, the letter was mailed without the calculations which are present below.

Thank you very much for responding to our letter of October 24, 1983. Below you will find a summary of our calculations based upon a total of 115,910 lbs./yr. of wet sludge containing 20.4 wt% solid and metal contents given as ppm or wt% values in the dry sludge.

		NCSU CALCLAUTIONS		
Component	Wt%, ppm	1b/yr of metal	Approximate $ Value of Metal	Comments or Corrections
Cd	<0.5 ppm	0.01	1.00	
Cu	1540 ppm	0.04	1.00	
Pb	11 ppm	0.26	~~0.90~~	
Ni	12 wt%	2,837.5	9,194.00	
Zn	2100 ppm	49.66	20.00	
Cr	2.2 ppm	0.05	4.00	
Fe	770 ppm	18.21	---	
Al	---	---	---	
Sn	<0.2 ppm	---	---	
Ag	<0.2 ppm	---	---	
Ti	<5 ppm	0.118	---	
TOTALS		2,905 lbs/yr	$9,220.00/yr	

We are aware of uncertainty in sludge composition and we would appreciate your feedback on the following questions concerning the correctness of the above values.

(1) Did we assume the analysis on a basis of wet or dry sludge correctly? If not, please indicate what fraction of your wet sludge was analyzed.

REFERENCE 1

STUDY - VALUE OF METALS

Reducing Metal Losses and Sludge Production in the Electroplating Industry
May 30, Raleigh, McKimmon Center - May 31, Charlotte Area, Holiday Inn, Carowinds
Program Ideas from Advisory Committee Meeting of February 22, 1984

A. Closing The Cycle

1. Zero Water Discharge, *Harry* DeSoi, Manager, Pioneer Metal Finishing: Describe his system, changes since last year, disposition and metal content of boiler solids, plans for sludge disposal.

B. Reducing the Treating Load

1. Good Housekeeping, Reducing Dragout, Rack Design, Recycling, Managing Off-Spec. Plating Baths, George McRae, Stanadyne, Sanford
2. Innovative Spray Rinsing, Jim Adams, NCR
3. Ni Recovery by Ion Exchange, Terry Parsons, Lufkin
4. Electrodialysis for Metal Recovery, Brian Wells, Ilco Unicam
5. Using Tri-Chrome, Terry Parsons, Lufkin
6. Using an Evaporator, Scott Wallace, Stratford (?)
   Roger Woods, Eastern Plating (OK)

C. Sludge Handling and Disposal

1. Drying Sludge, John Gouldin, Techmatic Corp., Nashville, TV(?)
2. Delisting Sludge, Barry Nelson, Moore Gardner and Assoc. (OK)
3. Selling or Recycling Sludges and Solutions, Stan Taylor, Data *General,* possibly Chris Hord, Surtronics, and Dikkran Kabbendjian, ITT

D. Regulations and Pollution Prevention Pays

1. RCRA - Changes in Reauthorization Act, Is Drying Sludge Waste Treating? How are Zero Discharge-Recycle Operations Treated? Status of Delisting Electroplating Sludge.
2. Pretreatment Requirements, Representatives from one or more public waste water treatment facilities.
3. **The** NRCD - P.P.P. Program as it Applies to Platers, Roger Schecter (CK)

F. Other Possible Subjects and Speakers (not all discussed at the meeting)

1. Lab Analysis of Sludges - speaker(?)
2. Reverse Osmosis - David Birkhead, Acme United (?)
3. State of the Art in Metal Recovery or Other Subject - F. Steward, Lancy Intl. (?)
4. Experience with Evaporators - Roger Woods, Eastern Plating (confirmed)
5. Electroplating sludge quantity and composition - J. Kohl or B. Triplett
6. Water pollution regulations affecting direct dischargers (?)

G. Evening Session

An Exchange of Experiences in Operating Waste Treatment Facilities:
Leader, Dikkran Kahbendjian

(2) Do our numbers for lbs. metal per year (as is or adjusted by your corrections in (1) above) appear at all reasonable considering the amounts of those metals you added to your plating baths in 1982? If the values for lbs. metal per year also reflect the metal resulting from acid etching, do they make sense or have you any basis for telling?

We have scheduled the Spring 1984 electroplaters' programs for Wednesday, May 30, 1984 in Raleigh at the NCSU McKimmon Center and for Thursday, May 31, 1984 in the Charlotte Area (Ft. Mill, S.C., Holiday Inn Carowinds). The attached sheet contains our program ideas. We will send you a flyer on these programs as soon as they are available.

Enclosed you will find an extra copy of this letter. We would appreciate your returning this letter with your comments by March 30, 1984 to:

J. Kohl, Sr. Extension Specialist, NCSU, P. 0. Box 7909, Raleigh, NC 27695-7909

We are convinced that we must find alternatives to the land burial of our metal containing wastes. Your help on this study can help us look at other options.

Sincerely,

Jerry Kohl (BT)

J. Kohl,Sr. Extension Specialist
(919) 737-2393

JK: sh

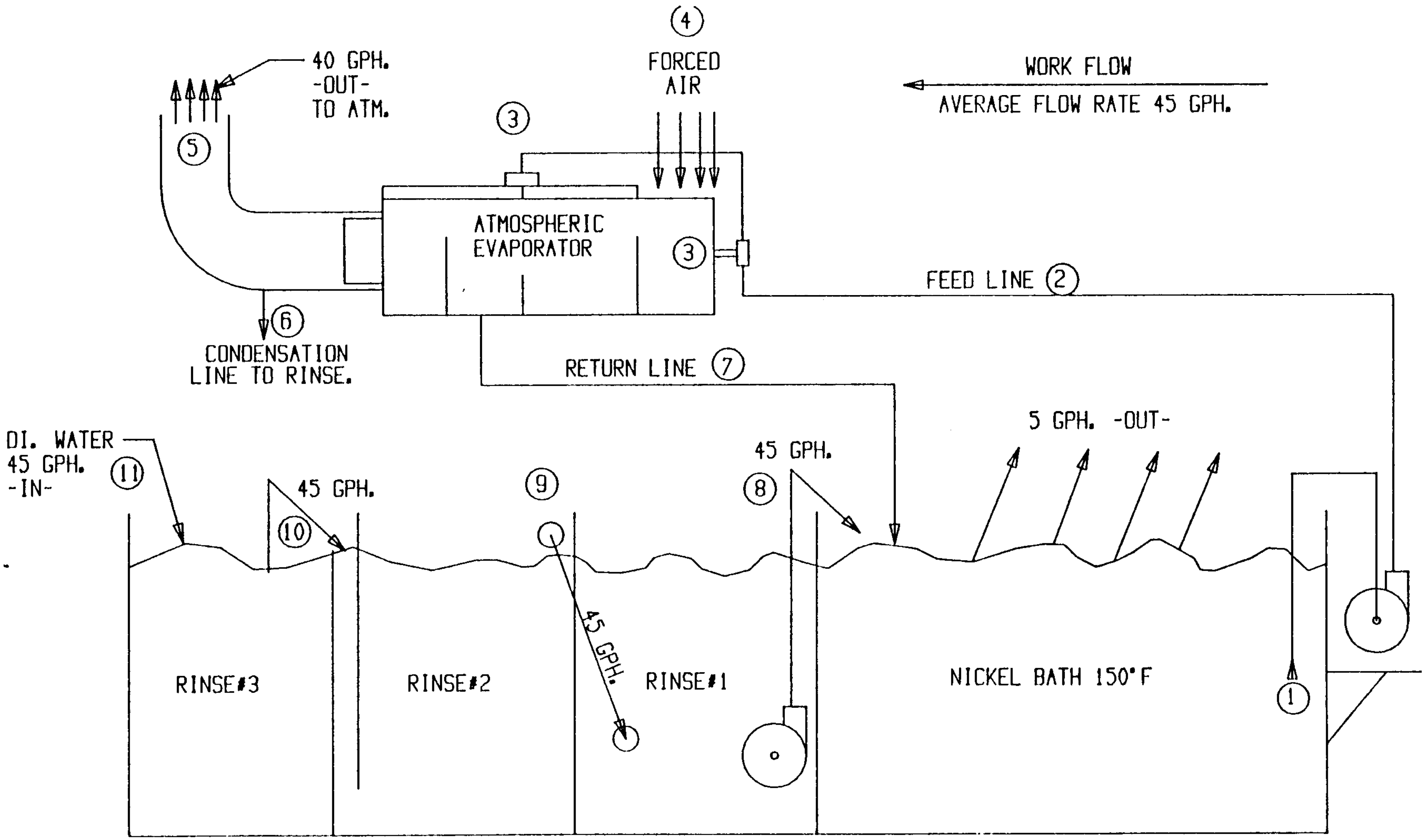


FIGURE 1: OPERATING SEQUENCE FOR ATMOSPHERIC EVAPORATOR SYSTEM

ILCO/UNICAN CORP.

PROCESS DESCRIPTION

The atmospheric evaporation process as applied to an electroplating process involves the installation of evaporators in close proximity to the electroplating or nickel plating baths. Consideration should be given to locating the evaporator close to a source of clean and dry air. A continuous flow of air which is humidified by the electroplating bath is drawn off and expelled to the atmosphere.

Unsaturated air absorbs moisture from a wet surface. Therefore, as the relative humidity drops, the evaporation rate increases. Head space or room is created in the plating tanks by taking advantage of the air's ability to absorb water while leaving the valuable constituents of the bath behind. The water evaporated is replaced by water from the rinse cycle.

Figure 1 illustrates the process sequence. The electroplating bath solution is pumped to the evaporator utilizing a magnetic drive March pump with ***a*** 1″ suction and 3/4″ discharge through the feed line to the two spray nozzles on top and one spray nozzle in the middle front of the evaporator. Latent heat of vaporization occurs upon passing through the spray nozzles and packing while coming into contact with forced air from a Dayton blower. The humidified air is expelled to the atmosphere through a 16″, 20 gauge galvanized duct, with a 1/2″ drain for condensation. The bath which is not evaporated returns to its original bath through a 1 1/2″ drain by gravity.

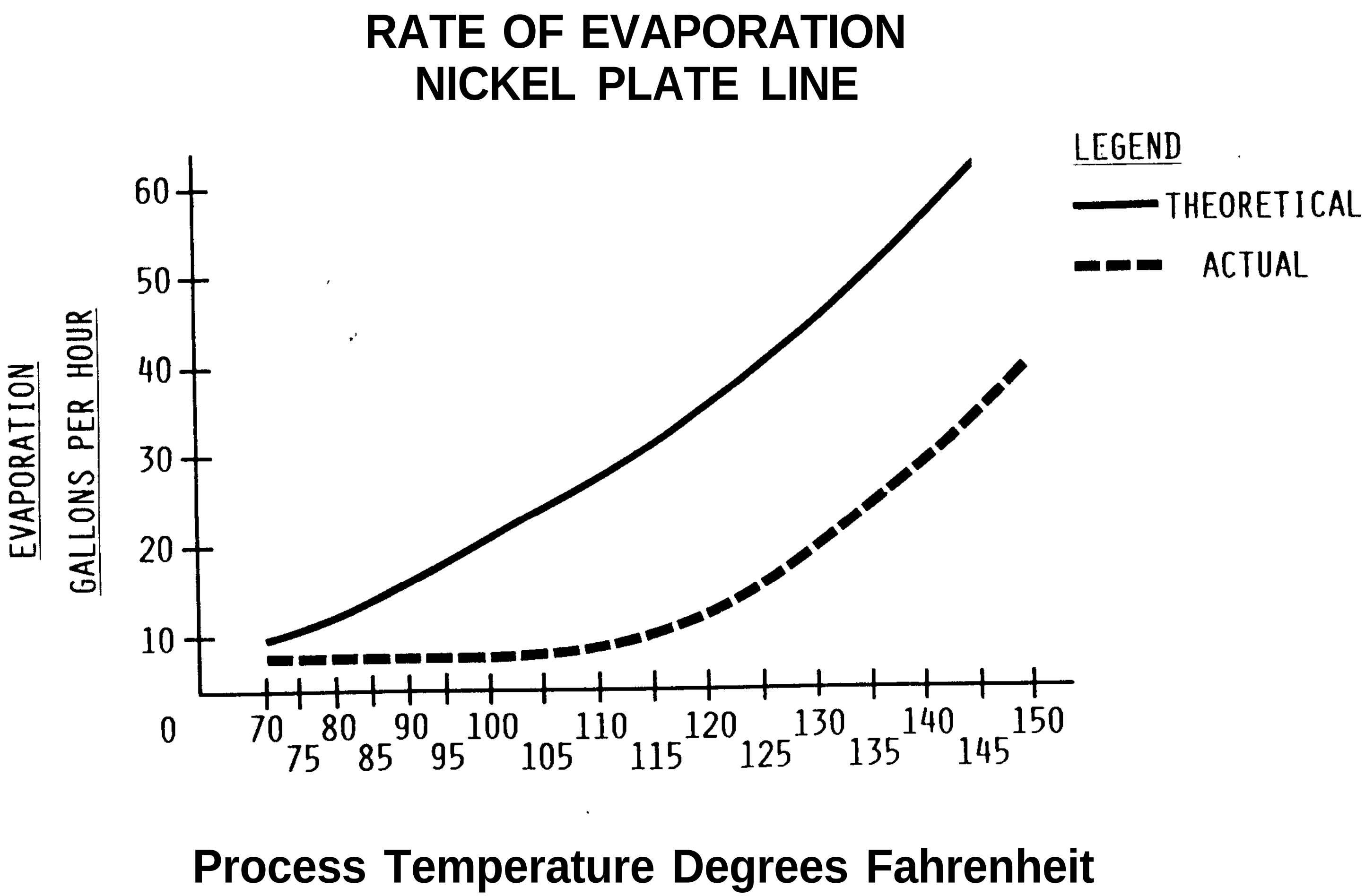

RATE OF EVAPORATION
NICKEL PLATE LINE
LEGEND
THEORETICAL
ACTUAL
EVAPORATION
GALLONS PER HOUR
60
50
40
30
20
10
0
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
Process Temperature Degrees Fahrenheit

FIGURE 2

The replacement of evaporated water in the nickel bath is accomplished by pumping from the Rinse #1. The amount of replacement is determined by the evaporation rate via a level control in the nickel bath. Simultaneously counterflow from Rinse #2 and Rinse #3 occurs as the level in Rinse # 1 drops. As the level is dropping in Rinse # 1 a solenoid valve is opened allowing for dionized water to enter Rinse #3.

Evaporation rates are variable and are determined by the surrounding air, temperature of the solution and flow of air. Conditions which favor evaporation are hot air, dry air, hot solution and high air flow. Figure 2 shows the manufacturers average actual and theoretical rate of evaporation. Actual, according to the manufacturer are results reported by users of the systems.

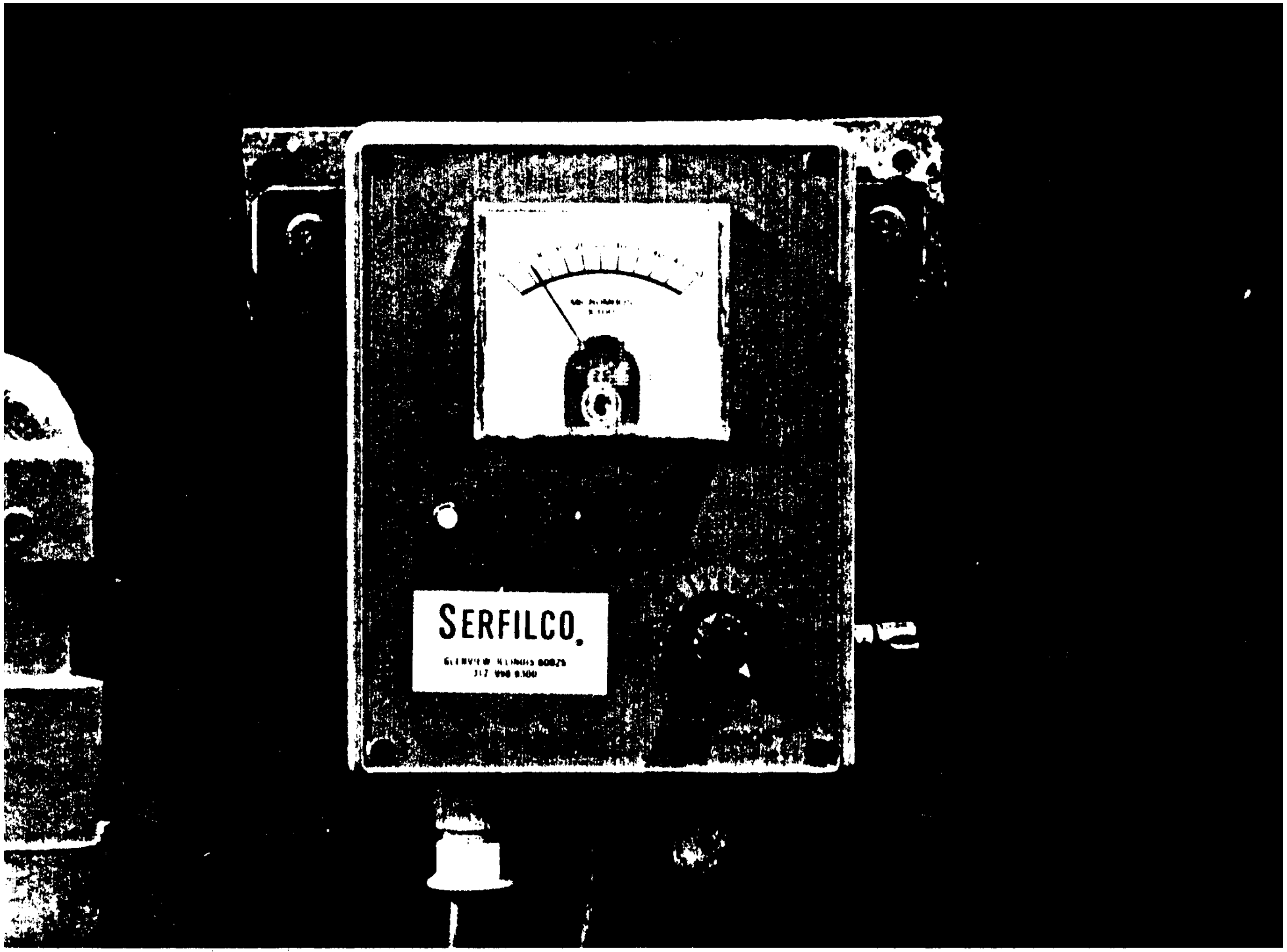


FIGURE 3 - SERFILCO CONTROLLER

TEST DESCRIPTIONS

This section describes the pre-installation engineering tests, equipment, the specific test set-up and operations.

PRE-INSTALLATION TEST

Initial testing was performed to determine a worst case to unacceptable rinse water by using a Serfilco Controller (see Figure 3) to measure the umho of the rinse water. Upon obtaining an inadequate plating on the products, testing would be discontinued. Inadequate was defined as a reduction in the brightness due to staining, or an off-color deposit or coating on the surface of the product.

Preparation for testing was accomplished by insuring the plating bath was optimal in composition and conductivity. Next all rinse tanks were drained, cleaned and replenished with clean water. A reading of 250 umhos was obtained from the clean rinse water.

During the testing period no clean water was introduced to simulate a closed-loop system. umho readings were taken every five barrels to simulate an accountable pattern of increased umhos to a worst case or unacceptable rinse water. All readings were taken in the final rinse.

FIGURE 4 - MAXIMUM CONDUCTIVITY TEST

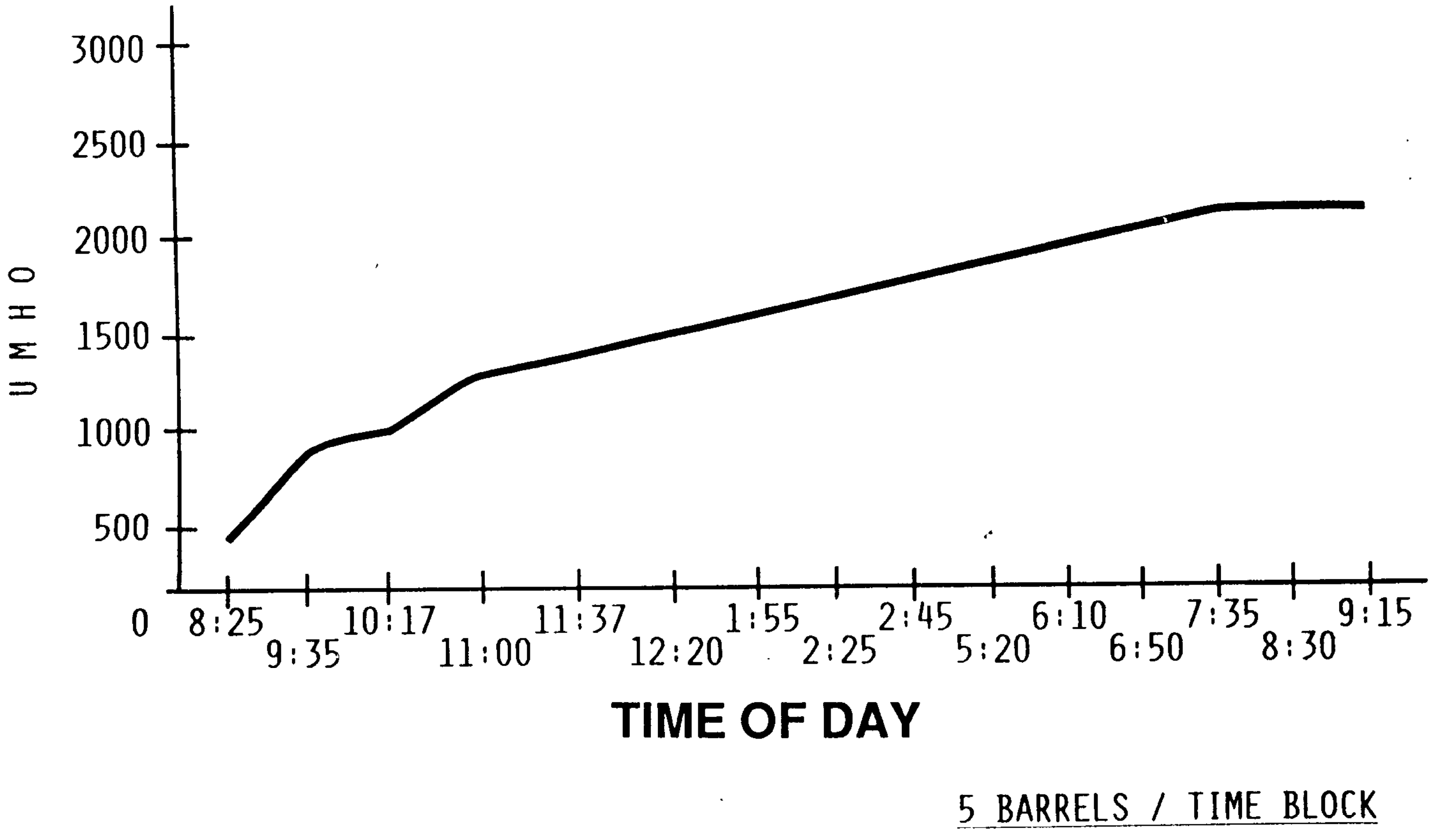


Figure 4 shows the starting point at 8:25 AM and the progression of increased conductivity. After 65 barrels the umhos increased to 2100. At this point a surface coating or haze appeared on the product and testing was discontinued.

The next phase of testing required drainage and cleansing of all rinse tanks again. The controller was now relocated to the first rinse tank following the bath. A temporary water supply and counterflow was installed. Water was flowed at a rate of 45 gallons per hour to simulate a 45 gallon per hour evaporation rate. A safety factor of 600 umhos was preconceived as a reduction in the factored 2100 umho set point. Therefore at 1500 umhos testing would again be discontinued at which time an increased flow of water would begin, if required.

The objective was to determine at what flow rate clean water could be introduced and keep the conductivity below 1500 umhos. At 7:30 AM a reading of 250 umhos was obtained on the clean rinse water. Over a 13 hour period umhos never exceeded 1000. At 8:30 PM plating was discontinued due to a lack of production. Table I reflects the hourly readings. umhos did stabilize one hour prior to the completion of production requirements.

EQUIPMENT

Two MAX-EVAP T.M. Atmospheric Evaporators manufactured by Techmatic, Inc., Nashville, Tennessee (See Figure 5) were installed following the engineering tests. Although the testing indicated

TABLE 1 - CONDUCTIVITY AT 45 GAL/HR FLOW RATE

TIME	uMH0
7:30	250
8:30	300
9:30	400
10:30	475
II:30	550
12:30	600
1:30	675
2:30	750
3:30	800
5:30	900
6:30	975
7:30	1000
8:30	1000

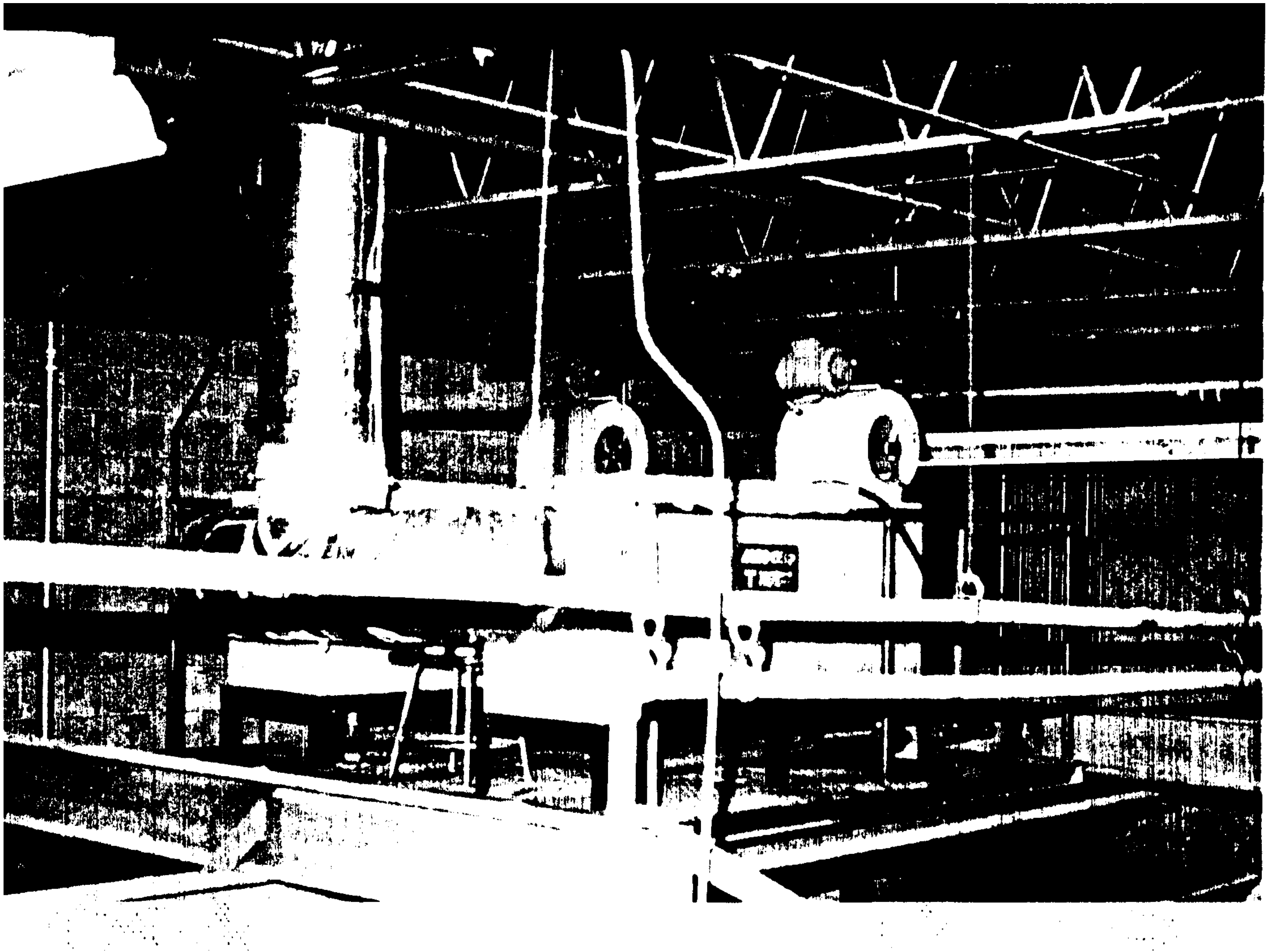
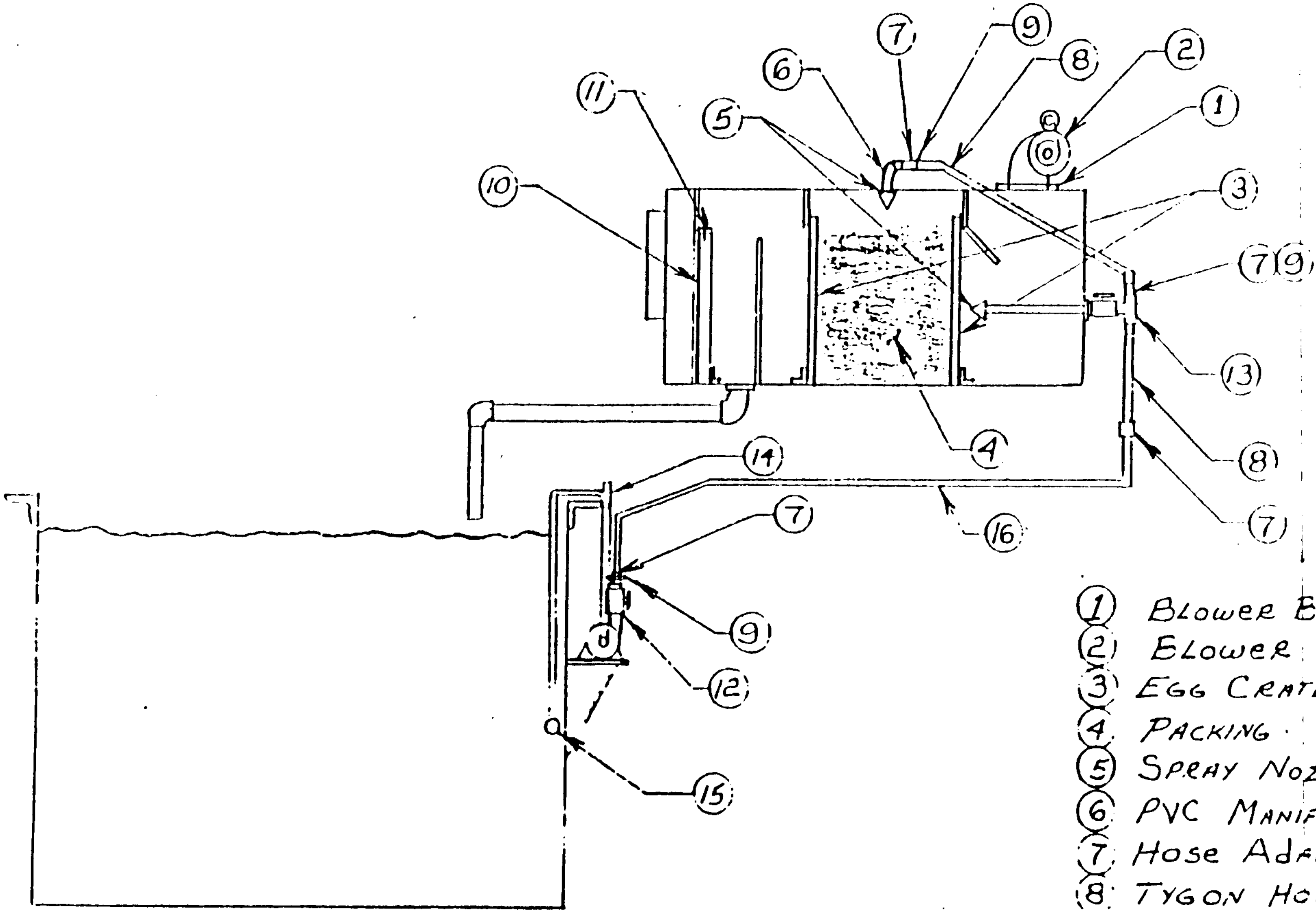


FIGURE 5 - INSTALLED ATMOSPHERIC EVAPORATORS



1. Blower Brackets
2. Blower
3. Egg Crate
4. Packing
5. Spray Nozzle
6. PVC Manifold
7. Hose Adapter
8. Tygon Hose
9. Hose Clamp
10. Chevron Dryer
11. Holding Pin
12. PVC Valve
13. Flush Assembly
14. Priming Tee
15. Footvalve-Strainer
16. 3/4" PVC Pipe

FIGURE 6

ASSEMBLY OF MAX - EVAP

TECHMATIC, INC.

a 45 gallon per hour flow rate was adequate to subside the conductivity to an acceptable limit. There was the probability that the 45 gallon per hour evaporation rate would occur only under favorable conditions, therefore two evaporators were utilized.

An 8′ x 8′ platform with guardrail was installed over the automatic hoist directly above both plating tanks. Assembly of the evaporators was relatively simple, (See Figure 6) Packing retainers (3), a packing material for atomization (41, spray nozzles (5), flush assembly (13), dryer (10), holding pin (II), and blower (2) were assembled to the evaporator. These parts were all assembled on the ground prior to placement of the evaporators on the platform.

Support stands were then fabricated for the March pump. Three (3) March pumps with stands were installed. One dedicated to each evaporator and one to transfer the rinse water to the plating tanks.

Following installation of the March pumps, the feed lines and return lines to the atmospheric evaporators were installed (See Figure 6) from the pump servicing the evaporators.

Rinse tank piping to the plating tanks required the placement of solenoid valves in-line to each plating tank. Solenoid valves would open as described below.

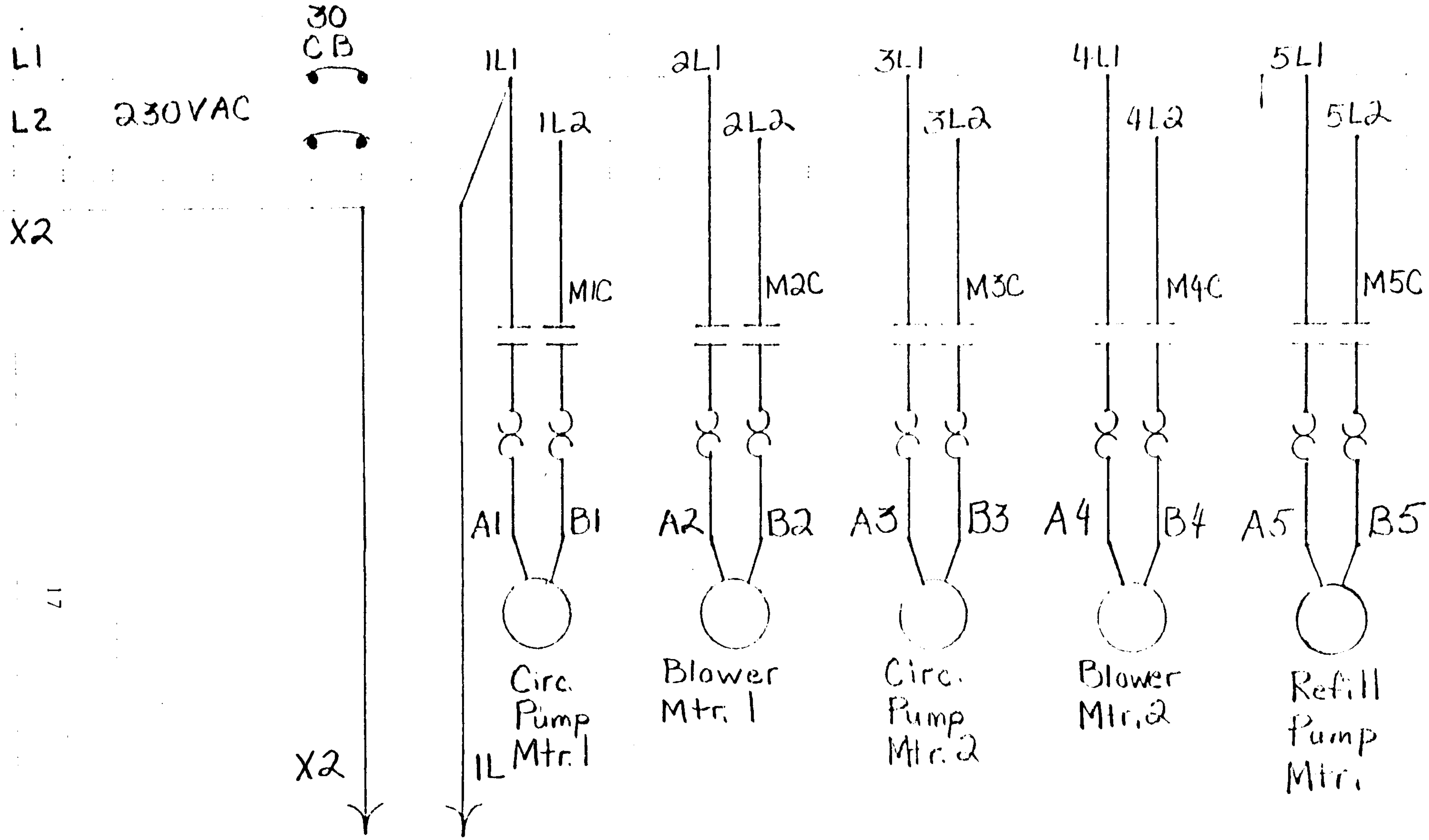


FIGURE 7 - ATMOSPHERIC EVAPORATOR CONTROL CIRCUIT

JOHN MESSER
ILCO UNICAN CORP.

An electrical control system design and control circuit was required. The circuitry designed is shown in Figure 7 and 8. When #1 Start Button is pushed or closed, the #1 Circulation Pump becomes energized allowing the pump to transfer the #1 Plating Tank bath to #1 Atmospheric Evaporator. This process continues until the #1 Stop Button is pushed.

When #2 Start Button is pushed or closed, #1 Dayton Blower becomes energized flowing air through the evaporator. The forced air stimulates the vaporization process and forces the atomized particulate through the evaporator and exhaust system to the atmosphere.

Start buttons #3 and #4 perform the same functions as #1 and #2 above, but, apply to #2 Plating bath and evaporator.

Pump #3, which supplies makeup water for plating baths #1 and #3 is energized when liquid level floats in the plating baths reach a set low limit. The liquid level floats activate and open the appropriate solenoid valve. Each plating tank has its own float and dedicated solenoid valve. This pump is controlled by either an automatic or manual selector switch. In the manual mode a bypass of the liquid level controller takes place.

A third liquid level controller was installed in the 1st Rinse Tank following the plating bath. This liquid level controller opens the solenoid valve at the fresh water supply to the 3rd Rinse Tank as the level is reduced in the makeup process.

Following the above installation process a tee-exhaust consisting of a 16”, 20 gauge galvanized duct with a 1/2 " drain for condensation was installed. The duct was emplaced through the facility roof and capped.

TEST SET-UP AND OPERATIONS

All valves were checked to insure proper positioning to draw from and return to the process tank. The pumps required a prime. Doors were removed to check the spray manifold for proper spray flow, and the return line was checked for flow back to the plating bath.

With blower in the off position, the Flush Assembly Valve required a partial opening, enough for a good flow without causing any splash to the blower. At this time the blower was energized to allow air to pass through the evaporator.

The dragout tank was cleaned and drummed for reuse. All, other rinse tanks were released and pretreated. Clean water was emplaced in all rinse tanks.

Plating operations were resumed, at which time tests were made to determine the actual rate of evaporation in each plating tank and the actual maximum umho during a normal production working day.

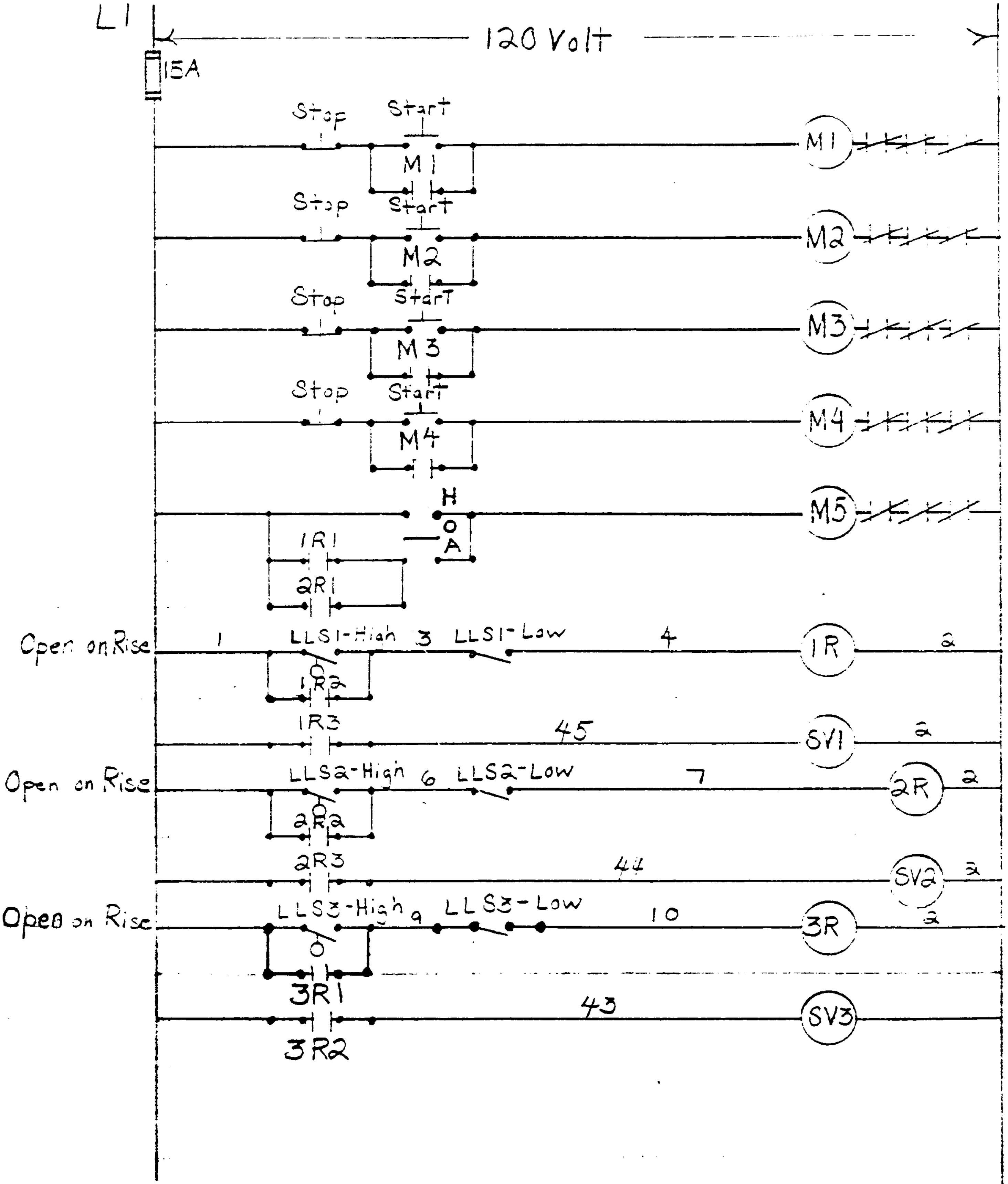


FIGURE 8 - ATMOSPHERIC EVAPORATOR CONTROL CIRCUIT

JOHN MESSER
ILCO UNICAN

COST ANALYSIS

As derived from the heat of vaporization 970 Btu per pound of water are required to change the state. Therefore,

970 Btu per lb. x 8.34 gal. = 8,089.8 Btu per/gal.

8,090 Btu per gallon of evaporation are required.

With the evaporation rate averaging between 60 - 70 gallons per hour 485,400 - 566,300 Btu or 4.85 - 5.66 therm per hour are used. Inasmuch as this electroplating operation runs 24 hours per day/6 days per week; 36,346 - 42,382 therms are required annually to operate the system. The cost per therm of natural gas at this facility is 47c per therm. Therefore energy costs at $17,082.00 - $19,920.00 can be expected annually.

Sodium would continue to buildup at a rate of 3% due to anode/cathode efficiency and recovery, eliminating any future costs of nickel sulfate and nickel chloride. Table 2 shows breakdown and assessment of cost, payback period and annual cost savings associated with this system.

TABLE 2 - COST AND PAYBACK ANALYSIS

	COST	SAVINGS
1. Plating chemicals		
Nickel Chloride		
$\frac{6400\#}{\text{ANNUALLY}} \times \frac{\$1.45}{\#} \times \frac{100\%}{\text{RECOVERY}} =$		\$ 9,280.00
Nickel Sulfate		
$\frac{22{,}000\#}{\text{ANNUALLY}} \times \frac{\$0.88}{\#} \times \frac{100\%}{\text{RECOVERY}} =$		\$19,360.00
Boric Acid		
$\frac{8800\#}{\text{ANNUALLY}} \times \frac{\$0.46}{\#} \times \frac{80\%}{\text{RECOVERY}} =$		\$ 3,238.40
2. Two (2) evaporator systems =	\$ 7,200.00	
Valves, switches, piping, Labor for installation, Ductwork for venting =	\$ 5,000.00	
3. Disposal Costs		
Roll-off rental		
$\frac{\$250.00}{\text{MO}} \times \frac{12}{\text{MO}} =$		\$ 3,000.00
Quarterly Transportation		
$\frac{837.76}{\text{QUARTERLY}} \times \frac{4}{\text{YR}} =$		\$ 3,351.04
Landfill Costs =		\$ 4,300.00
Labor to handle waste =		\$14,480.00
4. Maintenance on Evaporator		
$\frac{1\text{ Hr}}{\text{DAY}} \times \frac{312}{\text{DAY}} \times \frac{\$20.00}{\text{HR (OH)}} =$	\$ 6,240.00	

		COST	SAVINGS
5.	Annual Water		
	$\frac{20\ Gal}{MIN}$ to $\frac{60\ Gal}{HR}$ =		$ 2,636.93
6.	Sewer usage =		$ 1,318.OO
7.	Energy usage =	$18,501.00	
		$36,941.00	$60,964.37

1st year projected savings.................... $24,023.37

Subsequent annual savings..................... $36,223.37

Projected payback......................... 7.3 Months

Note:

Annual savings does not include an undertermined long-term liability savings.

CONCLUSIONS

Feasibility testing of the Atmospheric Evaporation system was successfully performed on the electroplating process from the Ilco Unican Corporation, Rocky Mount, North Carolina plant. In addition, analysis of the data from the tests provided the following conclusions regarding performance of the Atmoshperic Evaporation process.

- Processing parameters (bath composition, temperature, climatic conditions, energy efficiencies for the Rocky Mount process demonstrated the feasibility of using Atmospheric Evaporation to process plating bath composition and effectively use the rinse water as recovery source, therefore closing-the-loop.

- Sodium buildup has been a problem in the evaporator and the problem has been resolved by operating the pump approximately 30 minutes every 24 hours without the blower.

- Recovery of all salts, acid and brighteners normally disposed of, in addition to a generation of salts based on anode/cathode efficiency has occurred. Additionally a decrease of 50 - 80% in waste has occurred.

- Conclusions about the continual buildup of contaminants to the plating bath cannot be derived from the available test data. However, the plating industry is well aware of various treatments involving carbon filtration, hydrogen peroxide, electrolytic dummy plating, which allows removal of most contaminants should they build to a detrimental level.

- A off-line continuous dummy plate and treatment tank will be designed to decrease downtime associated with this process and any additional buildup of contaminants from the evaporator process.

- Atmospheric Evaporation is a cost-effective means.

Initial testing indicates the potential for the Atmospheric Evaporator to close-the-loop at the Rocky Mount plant. Based on the results of this feasibility test, adequate technical bases are available to design a system that is cost effective, efficient and act as a baseline for resolving problems associated with Atmospheric Evaporation in electroplating process.