

M C P

**Chemicals · Equipment · Process Technology
for
Metal Finishing**

Equipment for Electropolishing

©2000 Metal Coating Process Corporation
6101 Idlewild Road, Suite 134
Charlotte, NC 28212
704/563-0070

TABLE OF CONTENTS

1. Electropolishing Process Requirements	1
2. Console Units	2
3. MCP Standard Systems	4
4. MCP Custom Systems	6
5. Automatic Equipment	10
6. Special Applications	10
a. Electropolishing of Large Vessels	10
b. Electropolishing of Pipe and Tubing.....	10
7. Rental Units	10
8. Auxiliary Systems.....	12
a. Ventilation	12
b. Waste Treatment.....	13
9. MCP Technical Manuals.....	13
10. Terms & Conditions of Sale	14
11. Appendix	15

LIST OF ILLUSTRATIONS

Figure 1. Schematic diagram illustrating the normal sequence of steps to electropolish stainless steel.	1
Figure 2A-2C. Console Electropolishing Systems.....	2-3
Figure 3. Standard Electropolishing Systems	4
Table I. Other Sizes Available in "Standard" Series	5
Figure 4A-4C. MCP Custom Series: 200 gallon process line.....	6
Figure 5A-5B. MCP Custom Series: 350-gallon process line.....	7
Figure 6A-6C. MCP Custom Series: 700-gallon process line.....	8
Figure 7A-7B. MCP Custom Series: 1500-gallon process line.....	9
Figure 8A-8C. Automatic Rotative Arm and Tube Machines	11
Table II. Cost of Adding Ventilation to the MCP "Standard" Series Electropolishing Lines	12

1. ELECTROPOLISHING PROCESS REQUIREMENTS

Electropolishing is accomplished in a series of wet processing steps using specially designed tanks, similar to electroplating or anodizing. The parts to be polished are mounted on a rack or jig which is moved from tank to tank. The three major process steps of the electropolishing system are:

- PRECLEAN:** To remove all oils, lubricants, shop dirt, scale, oxides, and other contaminants from the surface. Suitable methods include vapor degreasing, solvent immersion, alkaline and/or acid soak cleaning, spray washing, abrasive blasting, wire brushing, and other types of mechanical finishing steps.
- ELECTROPOLISH:** To smooth, brighten, deburr, passivate, improve surface profile, hygienically clean, reduce friction, increase corrosion resistance. To remove and recover electropolishing solution.
- POST TREATMENT:** To remove chemical residues or by-products of electropolishing and to assist drying.

The process is comparable to any metal finishing operation such as plating or anodizing. Each of the major process steps may require more than one tank to achieve the desired results. Details of the system vary on a case-by-case basis.

Electropolishing systems require rinse water to remove solution from the parts after each chemical operation. These rinses usually go to drain, and are subject to Federal, State, and Local regulations affecting discharge to public sewer treatment systems. Most modern electropolishing systems now incorporate evaporative recovery and/or multiple rinse technologies to minimize the amount of rinse water used. MCP can furnish simple waste treatment packages warranted to meet current regulations. The MCP service often includes assistance with disposal of chemicals via a waste disposal company, thereby relieving small customers of major investments in waste treatment equipment.

Electropolishing baths generate both hydrogen and oxygen gases, producing an acid mist which must be ventilated to meet OSHA requirements. Other solutions in the line, such as cleaners and pickles, may also require ventilation to meet these regulations. MCP can furnish installed ventilation systems constructed entirely of PVC which meet or exceed such regulations.

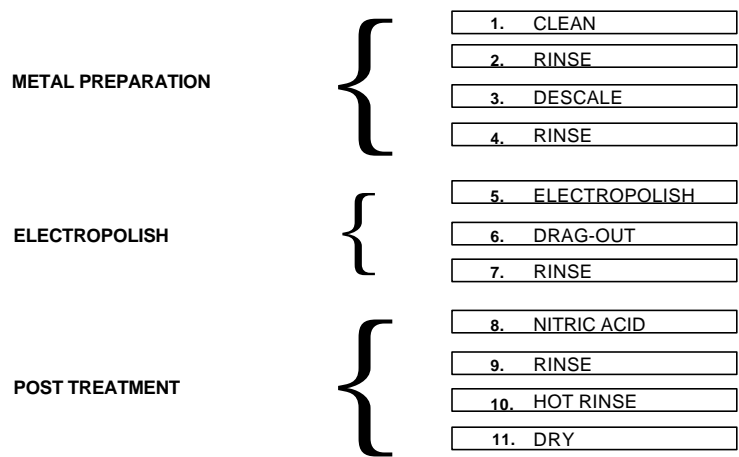


Figure 1. Schematic diagram illustrating the normal sequence of steps used to electropolish stainless steel.

2. CONSOLE UNITS

MCP "Console" units usually consist of the Electropolishing Tank, Drag-out Tank, and Rinse Tank only. Console systems are the smallest, least expensive systems available, and are intended for small-scale production, process development, and laboratory applications. The unit is usually enclosed in a cabinet with sliding access panels and recessed tanks. Precleaning and Post Treatment operations are normally accomplished in other equipment.

Console units are available in sizes ranging from 5-gallons to 45-gallons tank capacity. The DC power supply is sized for the tank volume, and includes voltmeter, ammeter, ampere-time control, alarm, and automatic power shut-off. The electropolishing tank is complete with anode and cathode bars, cathode plates, and electric immersion heater with thermostat and liquid level control. Installation normally requires only one electrical connection, drain connection, and one inlet water connection. DC outputs are available from 50 amps to 500 amps. Input power can be 110 volt or 220 volt, single phase. Prices range from \$8,995.00 for a 5-gallon unit up to \$26,750.00 for a 45-gallon unit.

Console electropolishing units may be designed to use any of the common electropolishing solutions. The Console systems are modular, and can be expanded to add metal preparation and post-treatment stations if desired. An example of an "expanded console" system is shown on Page 3 of this booklet.



FIGURE 2A. Typical console electropolishing system designed for prototype development at a major manufacturing company. This installation includes 2 precleaning and post-treatment modules.

2. CONSOLE UNITS (continued)

Special console units have been designed for production of small parts of intricate shape and exacting finish requirements. For such applications, the concept of the console system is expanded to include capability for precleaning, descaling, and post-treatment to produce the highest quality surface free of pits, burrs, and other microscopic imperfections. The process chemistry can be tailored to each individual application to produce the best results.

Console systems are equipped with a special interface to permit easy installation and connection to remote control panels. A start-up supply of chemicals and a comprehensive instruction manual are included with each complete process unit. On-site technical service for installation and start-up are available if required.

FIGURE 2B. Ten-station console system designed for precision electropolishing of small medical instruments. The system is completely equipped with ventilation hoods and duct, immersion heaters, digital temperature controls, and heated air dryer. All pipes and ventilation ducts are enclosed within the cabinet, with easy access provided through sliding panels in the front.

MCP Console Electropolishers are suitable for process development, pilot laboratories, and limited scale production. Systems are available in sizes from 5 gallons to 45 gallons.



FIGURE 2C. Each console model is equipped with one or more remote control panels to monitor the heating, drying, rectification, and other electrically operated functions. NEMA 12 remote panels provide maximum corrosion protection for sensitive electronic components.

Solid state rectifiers with extremely low ripple current and with ampere-time instrumentation are provided for electropolishing to close tolerances.

3. MCP STANDARD SYSTEMS

The MCP Standard Systems are complete electropolishing lines which are built from existing drawings. These systems consist of 10 or 12 tank stations, including the Precleaning, Electropolishing, and Post Treatment operations. The Standard series offers the highest possible quality with the convenience and economy of a small, compact process line.

The systems are designed for zero discharge of electropolishing solution, when used in conjunction with a thin-film evaporator. The evaporator concentrates the drag-out for re-use or for waste disposal.

The MCP Standard Systems can be furnished with ventilation hoods for each chemical tank to be connected by the customer with an existing fume removal system. MCP also offers a complete line of corrosion resistant PVC hoods, ventilating fans, mist eliminators, fume scrubbers, connective ductwork, and turnkey installation.

Equipment costs for complete 60, 100, and 150-gallon Standard processing lines range from \$41,760 to \$64,790. An outline of the features of a typical 60-gallon model in the MCP Standard series is shown on page 5 of this booklet. Table II lists the key parameters for the 100-gallon and 150-gallon sizes. Standard Systems are usually furnished as modular components for installation by the customer, following guidelines and layout drawings furnished by MCP. Supervisory assistance for installation and start-up will be furnished by MCP. Specially designed lines will be quoted upon request. Precleaning, Electropolishing, and Post Treatment modules are also sold separately if the complete system is not necessary for a given application.



FIGURE 3. MCP Standard Electropolishing System consisting of twelve processing stations, 60-gallons nominal capacity, with SCR power supply equipped for precision polishing, ventilating system, atmospheric evaporator, mist eliminator, and remote operator control panel. The line produces extremely high quality technical finishes for clean gas distribution systems.

TYPICAL STANDARD SERIES SPECIFICATION

Model No. 1060
Number of Tank Stations: 10
Nominal Tank Volume: 60 gallons

Applications: Production applications for racked parts up to about 150 square feet per eight-hour shift.

Construction: One (1) alkaline soak cleaner tank with skimmer and recirculating pump, equipped with electric immersion heater (or steam coil), digital thermostat, and liquid level control.

Two (2) acid tanks, one lined with "Koroseal" PVC sheeting, and one type 316L stainless steel.

One (1) electropolishing tank, lined steel or type 316L stainless steel, equipped with anode and cathode rails, cathodes, tank bussing, electric immersion heaters (or steam coil), digital thermostat, and rod agitator.

One (1) dragout recovery tank, PVC lined, equipped with electric immersion heater (or steam coil), digital thermostat, and atmospheric evaporator with pump and blower.

Four (4) cold water rinse tanks , PVC lined.

One (1) hot water rinse tank, type 316L stainless steel, equipped with electric immersion heater (or steam coil), and digital thermostat.

One (1) support stand, steel, for overall working height of 42" above finished floor.

Rectification: SCR remote controlled, 230 or 460/3Ø/60 Hz input, fan cooled, sized for tank and equipped for precision control of electropolished finish.

Advantages: Designed for top quality finishes at maximum production volume.
 Low floor space requirement, approximately 100 square feet.
 Requires only 1/2" inlet water piping, 220 or 440 volt electrical connection, 3" rinse water drain.
 Includes chemical test kit for simplified solution control.

Training: MCP will furnish up to three (3) man-days on-site supervisory assistance for installation and start-up without additional charge. The system includes one (1) set of MCP operating and maintenance instruction manuals. The on-site training program includes presentation of the MCP training seminar for system operators.

Price: \$41,760 FOB Shipping Point(s).

Table I. Tank Sizes Available in "Standard" Series Equipment

MODEL	NO. OF TANKS	TANK VOLUME	POWER SUPPLY	FLOOR SPACE	PRODUCTION PER SHIFT	PRICE
		(Nominal)	(amperes)	(approx.)	(estimated max)	FOB Shipping Point
1060	10	60 gallons	300	100	150 sq. ft.	\$41,760
10100	10	100 gallons	500	150	200 sq. ft.	\$53,850
10150	10	150 gallons	1000	175	500 sq. ft.	\$64,790

Revised 22 aug 2000

4. MCP CUSTOM SYSTEMS

Process systems larger than 150 gallons are usually engineered specifically for the end-use applications. The photographs on pages 6 through 9 of this brochure illustrate typical process lines built for specific industrial requirements

FIGURE 4A. This 200-gallon tank line consumes less than 2500 gallons of rinse water daily. The rinse system utilizes the counterflow principle to minimize water requirements. The line occupies a space approximately 8 feet wide x 60 feet long.



FIGURE 4B. The line includes an 8,000 cfm push-pull ventilation system to control air quality to current OSHA standards. Shown at left is the push air blower, located on a concrete pad outside the building. Push air ductwork can be seen in Figure 3A, above, mounted on the front rim of the tanks.

FIGURE 4C. The pull fan for the ventilation system is located on a steel platform stand as shown in the photo on the right. All components of the ventilation system are constructed from corrosion resistant PVC and are welded to eliminate the possibility of leakage.



MCP CUSTOM SYSTEMS (continued)



FIGURE 5A. Twelve-station line with 350-gallon electropolishing tank, ventilating system, evaporative recovery system, and semi-automatic waste treatment unit. The space occupied by the line is approximately 10 feet wide x 35 feet long. The ventilation system is designed for approximately 10,000 cfm. The line produces superior quality electropolished parts for semi-conductor and pharmaceutical applications.



FIGURE 5B. Semi-automated batch waste treatment unit neutralizes up to 2000 gallons of rinse water per shift. The system can be upgraded for automatic operation by modification of the computer control. An optional filter press can be added to minimize operator supervision and to maximize throughput of waste water.

4. MCP CUSTOM SYSTEMS (continued)

FIGURE 6A. Twelve-station line features 700-gallon electropolishing tank, evaporative recovery system, and batch waste water treatment unit. The space occupied by the line is approximately 16 feet wide by 20 feet long, with the tanks set in a “U-shaped” arrangement. The system produces high-quality work for semiconductor and pharmaceutical applications.



FIGURE 6B. Electropolishing tank bussed for 6000-ampere power supply. Note the arrangement of the copper buss rails to accommodate large parts requiring internal finishing. Electrolyte carried out of the tank by the parts is concentrated with the assistance of a 3-station counterflow rinse system and a heated evaporative recovery unit. The solution can be re-used until the metal content reaches the saturation limit of the electrolyte.

FIGURE 6C. Manually operated batch waste water treatment unit handles up to 2600 gallons of rinse water per shift. The waste water produced by the system is minimized through the use of a thin-film, atmospheric evaporator designed to concentrate and to re-use the electrolyte recovered from the rinse water. Spent electrolyte recovered by the system is returned to the manufacturing plant separately for disposal.



4. MCP CUSTOM SYSTEMS (continued)



FIGURE 7A. This twelve-station line features a 1500-gallon electropolishing tank with a 6000-ampere power supply. The system is designed for handling large volumes of flat sheets for food manufacturing equipment.

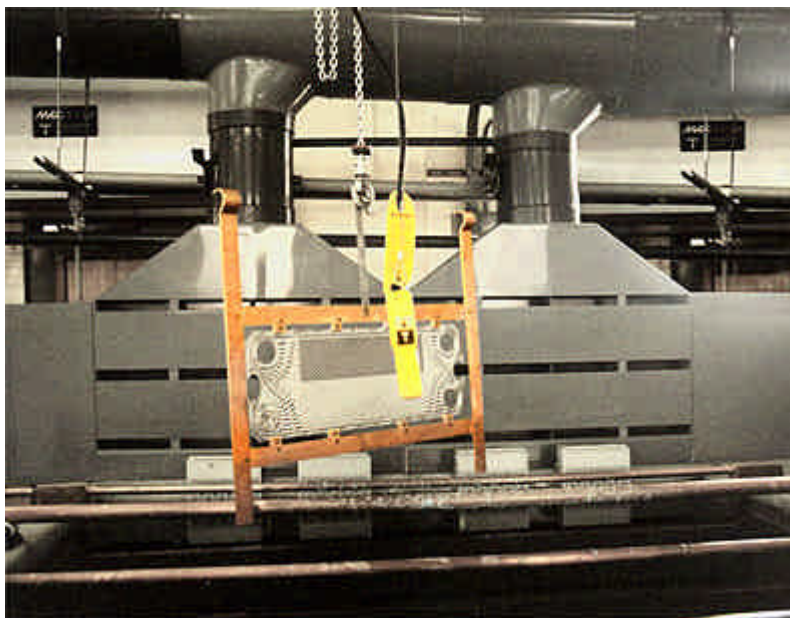


FIGURE 7B. Note the heavy copper bussing used for distributing the current to the work. The ventilating system for this line is designed for 17,000 cfm. The thin-film atmospheric evaporator used in recovery of the electrolyte is visible at the upper left of the photo.

5. AUTOMATIC EQUIPMENT

Automatic lines are available in a circular, rotative-arm design with programmable time cycle. These machines vary from about 8'- 36' in diameter, with power supplies from 100 amps to 7,000 amps. The equipment is designed for top quality finishes in high production volume. Capital costs range from about \$60,000 to \$250,000 depending upon the model required. The design includes the ventilation hood and fan for the tanks, less ductwork. Installation and waste treatment equipment are additional.

Custom-built, automatic machines are also available for rack processing, using typical straight-line, or return-type, programmable hoists. Such machines generally start in the range of \$200,000, increasing with size and features.

For bulk processing of small parts, MCP can furnish a bulk-processing machine capable of handling up to 200 lbs per hour of work. This machine is complete with materials handling system and Post Treatment operations. Precleaning, if necessary, must be accomplished off-line. The machine costs approximately \$180,000 plus certain optional extras.

6. SPECIAL APPLICATIONS

a. ELECTROPOLISHING OF LARGE VESSELS

Electropolishing the interior surfaces of tanks, mixers, and other large pieces of equipment requires the use of special equipment and techniques depending upon the product to be polished and the finish specifications. Sometimes the tank can be filled with solution and used as its own vessel for polishing; in other cases, the tank is partially filled with solution and is rotated around a stationary cathode to achieve the desired finish. Internal tank finishes in the range of 0.5 RMS units are reportedly produced in this manner.

An investment of \$25,000 - \$100,000 is typically required to establish the capability to electropolish tanks; the cost varies with the size of the tanks and the production volume.

b. ELECTROPOLISHING OF PIPE AND TUBING

Manual or automatic machines are available for electropolishing the inside surface of stainless steel pipe. Lengths of pipe or tubing up to 30' are handled in production volumes using such machines.

The principle involves pumping electropolishing solution through the pipe and using either stationary or moveable interior cathodes which distribute the current along the length of the pipe during the electropolishing cycle. The equipment can be designed to polish up to 20 lengths of pipe or tubing simultaneously. Machines have been built to process tube diameters ranging from ¼" to 6". Finishes in the range of 3-5 microinches are achieved by these methods.

The typical investment for a semi-automated machine to electropolish tubing in the range of 1/4" to 2" in diameter varies from \$80,000 to \$200,000 depending on the number of different diameters to be electropolished and the production volume.

7. RENTAL UNITS

Some prospective buyers prefer to experiment with electropolishing in their own plants before purchasing a full-sized, production system. MCP has rental electropolishing modules available for this purpose. In addition to a monthly rental fee, the customer must purchase the electropolishing solution required, make a security deposit, and sign a confidentiality agreement. MCP will credit a portion of the monthly rental fee toward the purchase of a complete electropolishing system. Technical assistance for operating the system and/or conducting trials is available from MCP on a consulting basis

4. AUTOMATIC EQUIPMENT (continued)

FIGURE 8A. This rotative arm machine is automated to produce about 10,000 small pieces per shift. The control panel operates all machine parameters and can be programmed as required for other work. The operator runs the machine from a single station, loading and unloading racks as they return after completing the process cycle. The machine is about 10 feet in diameter x 12 feet high.



FIGURE 8B. The rotative arm machine on the left is programmed to electropolish about 5,000 small medical parts per shift. The machine has nine process stations and two 100-amp rectifiers. The machine has a diameter of about 6 feet and an overall height of about 10 feet. All operations are automatically performed by the PLC located in the operator control panel.

FIGURE 8C. The electropolishing machine on the right is designed for simultaneous ID electropolishing of ten tubes, 20 feet in length. The capability of the machine includes selected tube diameters from ¼" to 1". Typical production rates are about 2000 feet of tubing per shift. Finishes in the range of 35 R_a are routinely achieved.

Machines have also been designed for larger size pipes up to about 6" in diameter.



8. AUXILIARY SYSTEMS

a. VENTILATION

The Occupational Safety and Health Administration (OSHA) requires that all open tanks which are heated, or which contain acids, must be ventilated. In addition, most states now have laws requiring that manufacturing plants inform workers of potential hazards associated with chemicals used in the workplace. These facts, coupled with a desire on the part of industry to create a safe work environment, generally lead to installation of some type of ventilating system for the electropolishing shop.

Ventilation equipment furnished by MCP for electropolishing lines is constructed from rigid PVC sheet and extruded shapes. Joints are welded to eliminate leaks and to provide rigidity. All fittings and ductwork are designed to ensure smooth flow of air at constant velocity. Hoods are fitted with quadrant-type dampers to permit balancing of the system under various operating conditions.

System designs vary with the layout of the electropolishing line. The most common systems utilize upright, slotted hoods at the rear of the tank, allowing sufficient clearance for passage of the materials handling hoist. Hoods are connected by appropriate PVC ductwork to the main fan mounted on the roof or on a stand outside the building. Fans are sized for the total air flow requirement and are constructed entirely of PVC.

Some tank configurations require "push-pull" ventilation for maximum efficiency. In such cases, the draft created by the main fan is augmented by a blower designed to force air through a distribution system and to sweep the fumes from the front of the tank toward the vertically mounted hood. In special cases, lateral or down-draft hoods may be required.

MCP ventilation systems are professionally designed for electropolishing lines. Guidelines used are those of the American Conference of Governmental Industrial Hygienists. OSHA standards, as published by the Federal Register, CF29CFR1910, are followed. Each ventilation system is specifically designed to fit the space available in the electropolishing shop. The customer must furnish certain details such as the roof height and type, the electrical power requirements, and other details which may affect air flow. Plan and elevation drawings are routinely submitted for customer approval prior to the start of construction of the ventilating system.

Specific quotations must be developed for most lines. However, as a budgetary guide, the table below lists approximate costs of adding ventilation to the MCP Standard series of tank lines.

Table II. Approximate Cost of Adding a Complete Ventilation System to the MCP "Standard" Series of Equipment

MODEL NO.	TANK VOLUME	# HOODS	APPROX. COST (EQUIPMENT ONLY)
1060	60	6	\$19,160
10100	100	6	\$25,761
10150	150	6	\$30,051

Revised 22 Aug 2000

8. AUXILIARY SYSTEMS (Continued)

b. WASTE TREATMENT

Discharge of waste water from electropolishing lines is governed by the Environmental Protection Agency (EPA) and related state and local authorities. Electropolishing shops must be in compliance with all Federal, State, and Local requirements for waste water discharged to ground water or to a Public-Owned Treatment Works (POTW). In general, MCP recommends that electropolishing lines be located on a sewer line discharging to a POTW.

The MCP system for handling waste treatment divides the total effluent from the line into two parts:

1. The "drag-out" from the electropolishing tank and its rinse(s), and,
2. The "acid/alkali" waste water from the cleaner, the acid descale, and the post-treatment nitric acid.

Waste water from the "acid/alkali" tanks and their rinses is collected into a common sump, from which the combined waste water is pumped to a storage tank of suitable capacity. The combined effluent is tested for pH and other chemical and physical parameters specified by the waste water authorities. If no further treatment is needed, the combined effluent is discharged to the POTW. If the combined effluent does not meet the parameters specified by the POTW, pretreatment is indicated. Installation of a pretreatment system may require a special license, and the customer should be diligent in determining what permits must be obtained.

MCP furnishes skid-mounted batch waste treatment modules specially designed to handle wastes from electropolishing lines. These modules usually handle 50 gallons to 5000 gallons of effluent per day, and may be either manual or semi-automatic. The standard models utilize a bag filtration system which produces a pourable solid sludge of about 15% solids. Options include the addition of a filter press which further reduces the water content of the sludge to form a non-fluid cake of about 30-40% solids. Sludge drying equipment is also available for reduction of the weight and volume of the filter cake. Continuous flow systems can be offered for systems requiring large water volumes.

Properly operated, the skid-mounted batch waste treatment system produces a clear liquid suitable for discharge to the POTW and a solid, metal hydroxide sludge which must be shipped to an approved hazardous waste landfill. The customer is furnished with a conditional warranty, guaranteeing that the system will meet the EPA and/or local requirements. Costs for the skid-mounted systems range from \$22,700 for the manually operated model with bag filter system to \$65,500 for the semi-automatic model with sludge settling device and filter press.

9. MCP TECHNICAL MANUALS

Each MCP process system is complete with a set of technical manuals covering the following subjects:

- | | |
|------------------------|--|
| a. Chemicals: | Technical literature, Material Safety Data Sheets, and related information. |
| b. Equipment: | Manufacturer's literature and warranties on component parts. |
| c. Process Technology: | Station-by-station description of installation, operation, and maintenance instructions. |
| d. Specifications: | Typical specifications published for electropolished finishes. |
| e. Literature: | Selected publications related to electropolishing. |
| f. Bibliography: | Comprehensive listing of published articles, patents, and technical conferences on electropolishing. |
| g. Drawings: | Layout and utility drawings related to the project. |

A general seminar covering the principles of electropolishing is furnished with each process system. MCP also provides periodic educational seminars on electropolishing at its Charlotte, NC, offices.