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DEMONSTRATION OF ALTERNATIVE DECONTAMINATION TECHNIQUES AT THREE MILE ISLAND

MASTER

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DISCLAIMER

INTRODUCTION

General Public Utilities Service Corporation and the Department of Energy division of Light Water Reactors are co-sponsoring a demonstration of the effectivness of a variety of decontamination techniques. The project is composed of three tasks listed below:

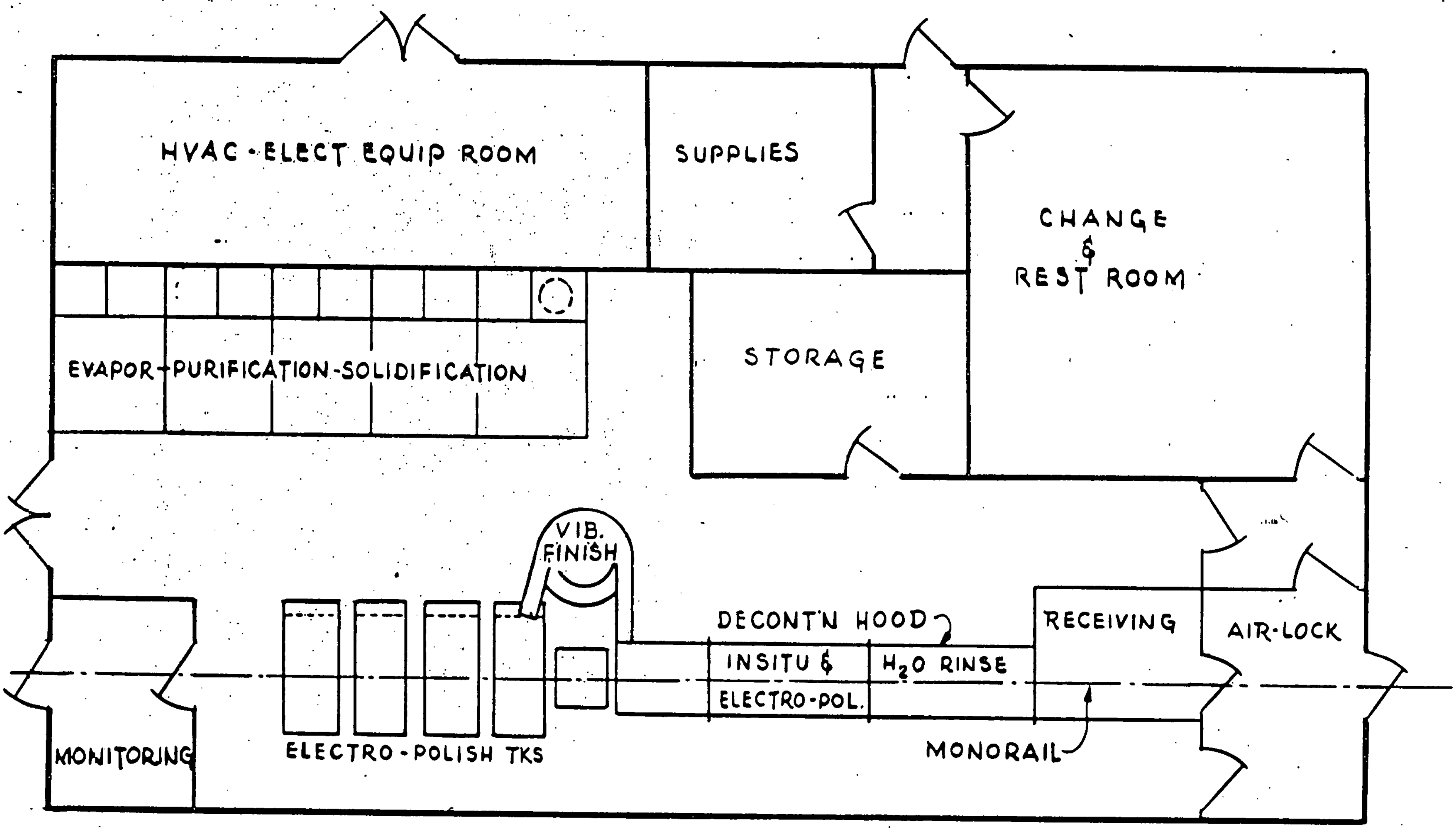
1. This effort will involve preparation for the demonstration and will consist of design engineering for any necessary plant modifications and construction of any special facilities needed to conduct or support the demonstration. This task also provides for any process technology development that is needed.

2. This task involves the performance of the demonstration, the determination or results or effects as they relate to the reduction of occupational radiation exposure and plant operation and the determination and dissemination of results.

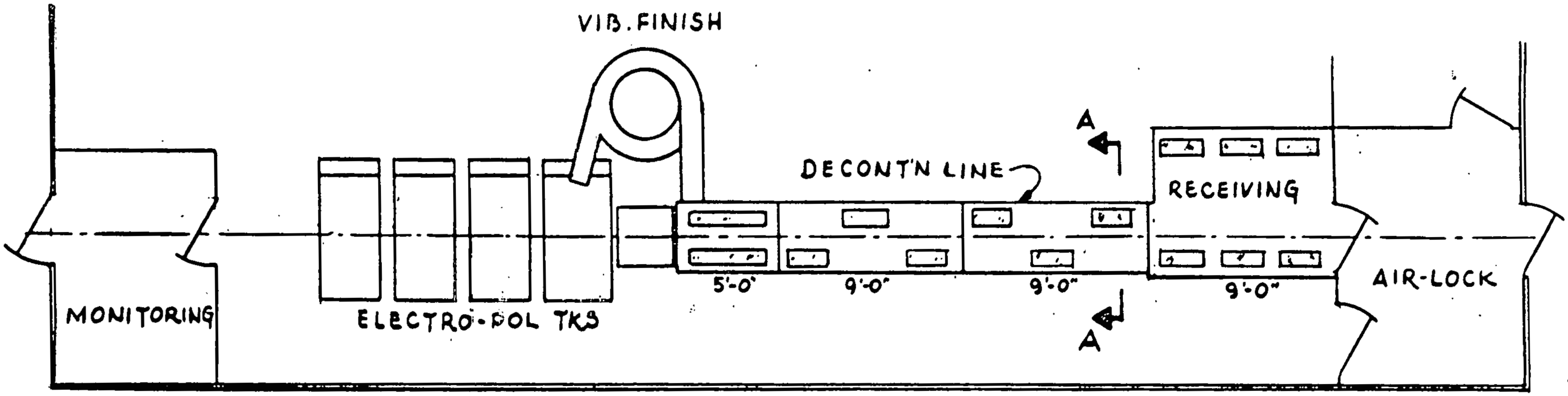
3. The intent of this task is to provide information for government use should it be desired at some future time to construct a mobile decontamination facility employing the processes or techniques developed at TMI. The information is needed to help select the design of a mobile facility that would be most effective in minimizing radiation effects, waste volume and recovery time from accident. This task should provide a cost/benefit analysis for a mobile facility compared to a facility assembled at the site where it is to be used.

Discussion

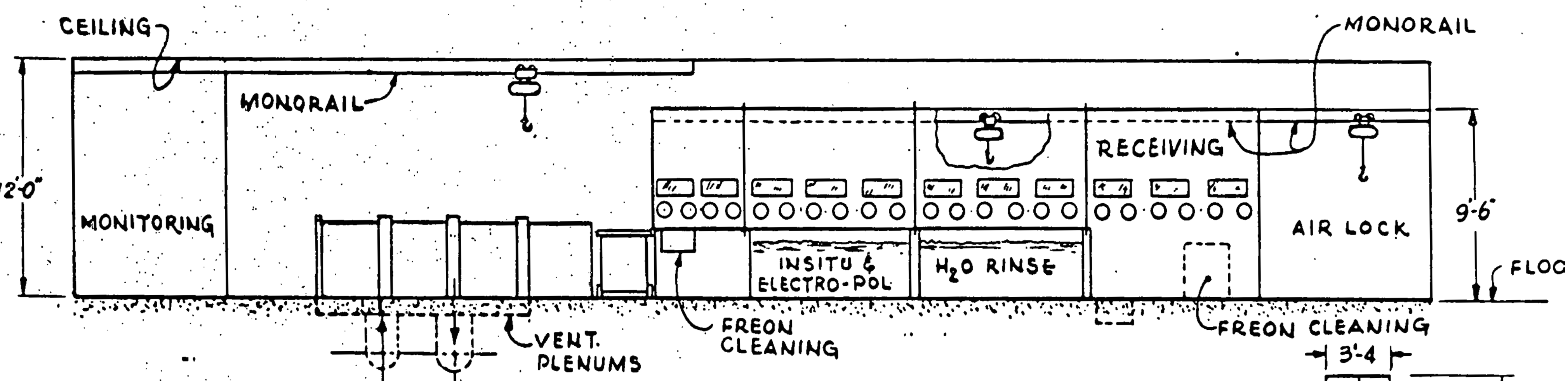
A recovery building is being designed by Bectel Corp. for use in the recovery of the containment building at Three Mile Island. The DOE-GPU sponsored decontamination facility will be housed in this building.



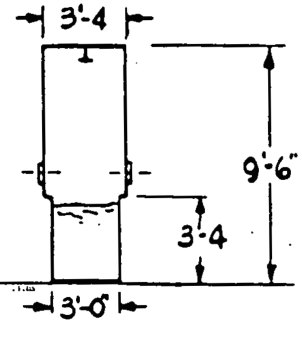
LAYOUT FOR THE DECONTAMINATION FACILITY AT THREE MILE ISLAND - SCALE 1/8" = 1'- 0"



PARTIAL PLAN VIEW



ELEVATION



A PARTIAL PLAN VIEW AND ELEVATION DRAWING OF THE DECONTAMINATION FACILITY - SCALE 1/8" = 1'- 0"

DECONTAMINATION TECHNIQUES TO BE EVALUATED AND COMPARED

- Immersion Electropolishing
  - A. Acid Electrolyte
  - B. Basic Electrolyte
- In Situ Electropolishing
- Barrel Electropolishing
- Vibratory Finishing
- High Pressure Spray
- Freon Cleaning
  - A. Immersion
  - B. Spray

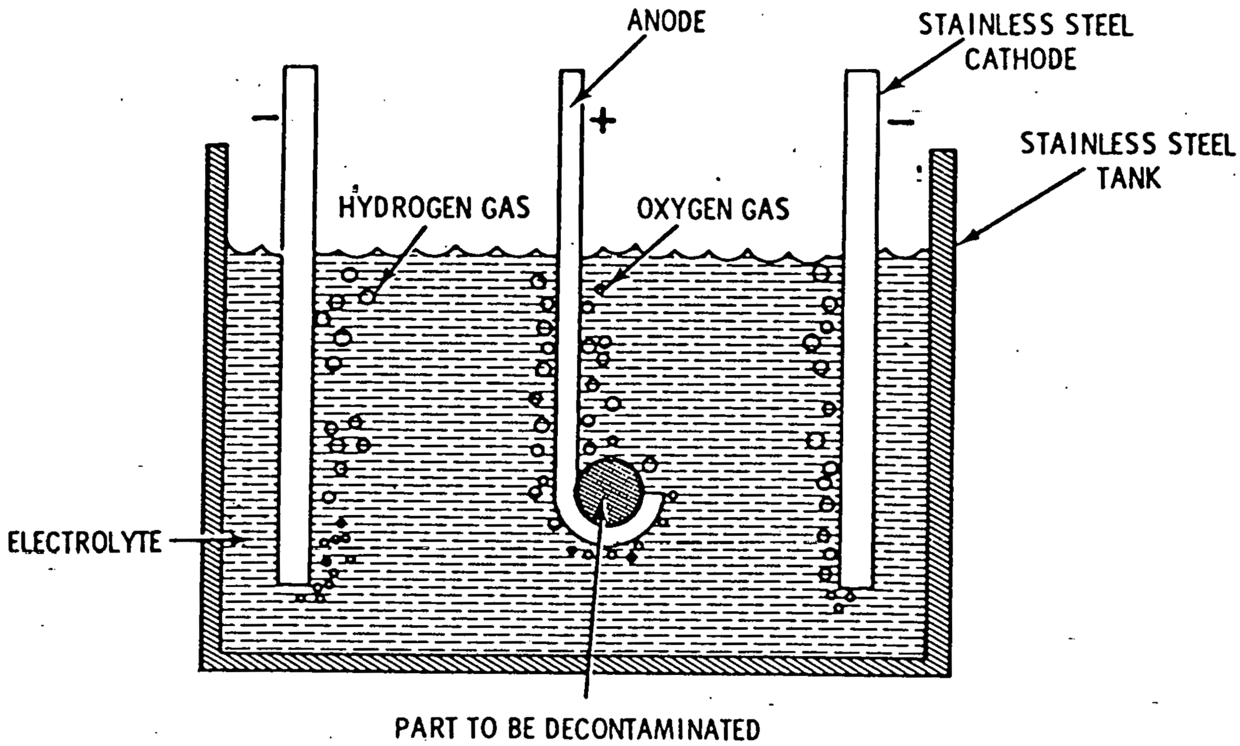


FIGURE 1. Schematic Drawing of the Type of Electropolishing Cell Used to Decontaminate Metal Surfaces

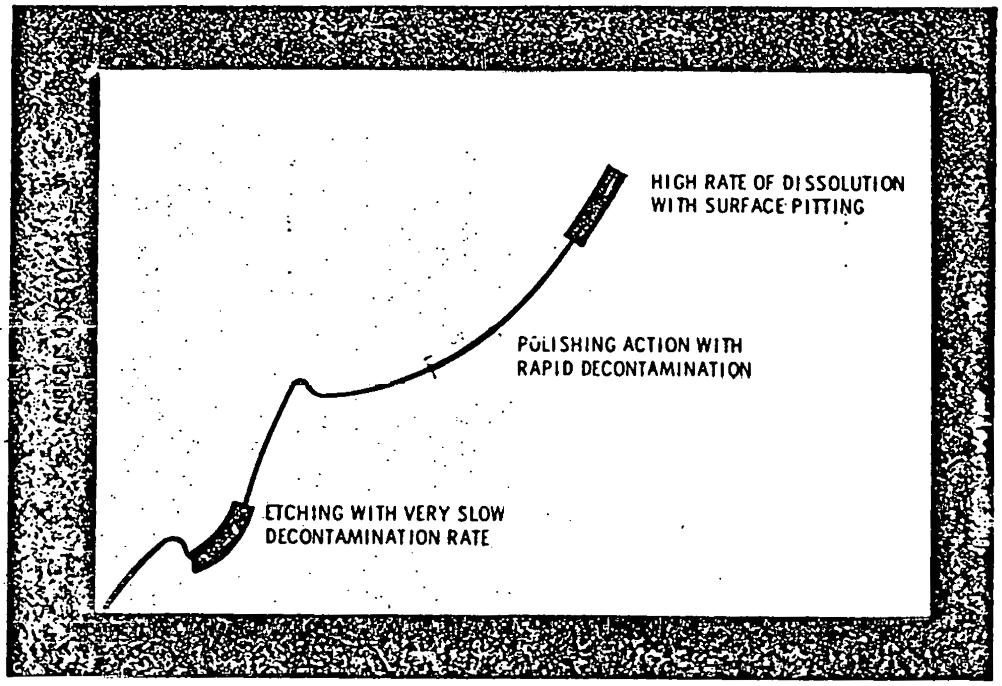


FIGURE 2. Relationship of Current Density and Cell Voltage for Electropolishing Showing Optimum Operating Region for Electrochemical Decontamination

DISCUSSION

Electropolishing Process

Electropolishing is an electrochemical process used in both laboratory and industrial applications to produce a smooth, polished surface on a variety of metals and alloys. Studies have shown that electropolishing is a versatile, rapid, and effective decontamination technique for radioactive metallic surfaces. Its versatility has been illustrated by its ability to decontaminate compositions ranging from mild steel, copper, and aluminum to stainless steel and highly alloyed, corrosion- and heat-resistant materials. Electropolishing can also be used to decontaminate, without prior disassembly, relatively complex components and shapes, including assemblies with moving parts. Special electrodes can be used as required for the in situ electropolishing of objects that cannot be accommodated in an electrolytic cell. Moreover, electropolishing is effective for a variety of radionuclides including plutonium, uranium, radium, cobalt, strontium, cesium, and americium and for contamination that is baked-on, ground-in, or otherwise difficult to remove using conventional decontamination procedures.

Electropolishing is an intrinsically simple process with no moving parts except as required for circulation or agitation of the electrolyte. Thus, it is amenable to remote operation and mechanization to further minimize personnel exposure. Experience also has shown that the smooth surfaces produced by electropolishing are much easier to clean using standard decontamination techniques than metal surfaces with a normal as-received finish.

The object to be electropolished serves as the anode in an electrolytic cell. The passage of electric current results in the anodic dissolution of the surface material and, under proper operating conditions, a progressive smoothing of the surface. Any radioactive contamination on the surface or entrapped within surface imperfections is removed and released into the electrolyte by the surface dissolution process. The amount of metal removed from the component surface to effect decontamination is usually less than 0.002 in. and is removed uniformly with no preferential attack of grain boundaries or other microstructural features. In fact, the surface produced by electropolishing usually has better corrosion resistance and other properties than did the original surface.

Phosphoric acid is used as the electrolyte and is used because of its stability, safety, and applicability to a number of alloy systems. In addition, the hygroscopic nature of phosphoric acid helps minimize airborne contamination and the good complexing characteristics of phosphoric acid for metal ions may be a significant factor in minimizing recontamination from the electrolyte. Other acids and chemicals can be added to the phosphoric acid as required to enhance surface passivity, increase brightness, or promote sludging.

An electrolyte based on sodium nitrate has been developed for the electrocleaning of highly radioactive surfaces. The advantage of this electrolyte is that the removed contamination and dissolved metals immediately form a precipitate which can be easily separated from the liquid. This basic electrolyte will be used for the initial decontamination of components which are highly contaminated.

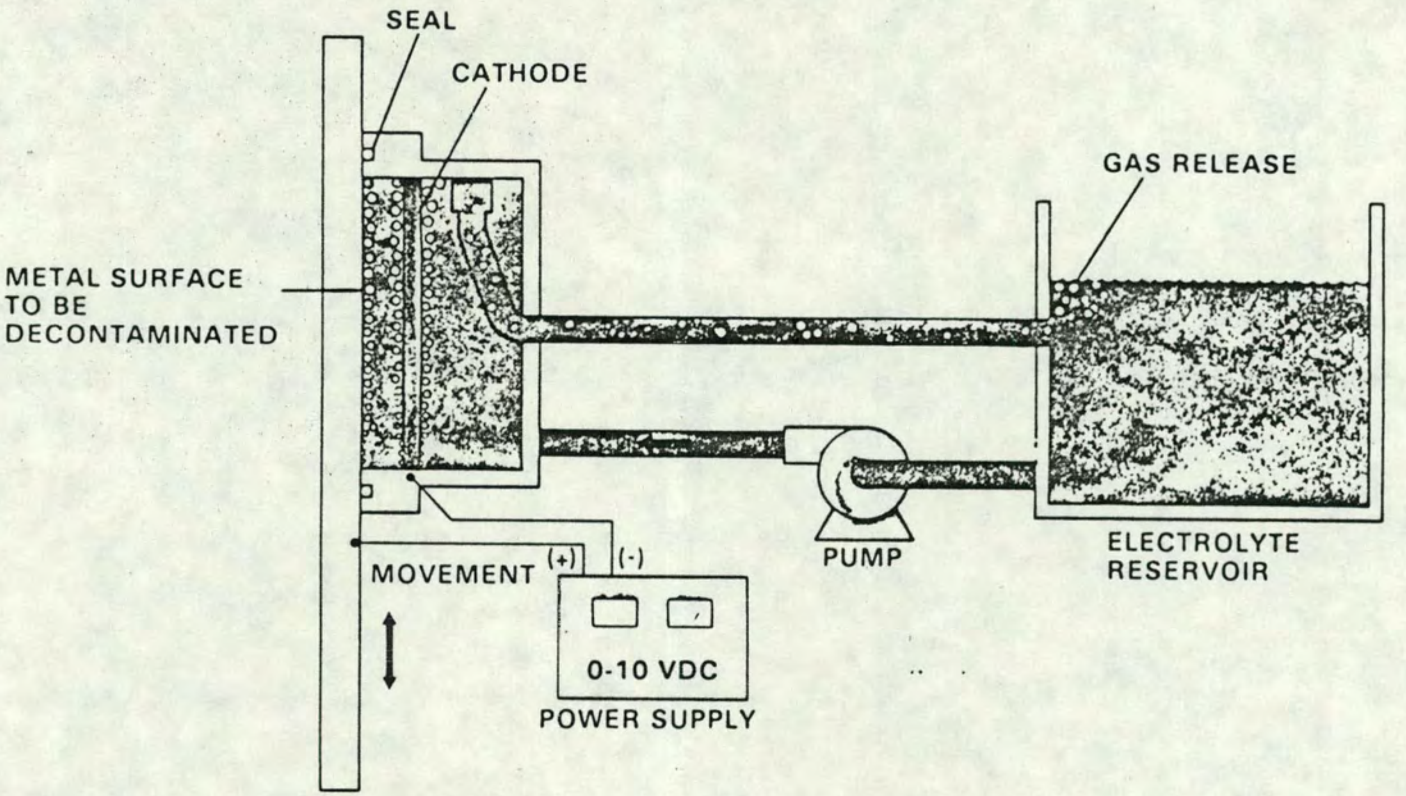
IN SITU DECONTAMINATION TECHNIQUES

- CONTACT IN SITU
- PUMPED STREAM
- BRUSH
- INTERNAL CATHODE

Discussion

In situ electropolishing techniques are under development for use in decontaminating large tanks, the interior of long pipes, pool walls, and other contaminated surfaces that either cannot be transported to or immersed in a conventional electropolishing cell. In situ techniques should have many applications in decontaminating valves, pumps, piping, pool walls, and other components of TMI #2 and other operating nuclear industry facilities to reduce radiation exposure and facilitate maintenance and inspection operations.

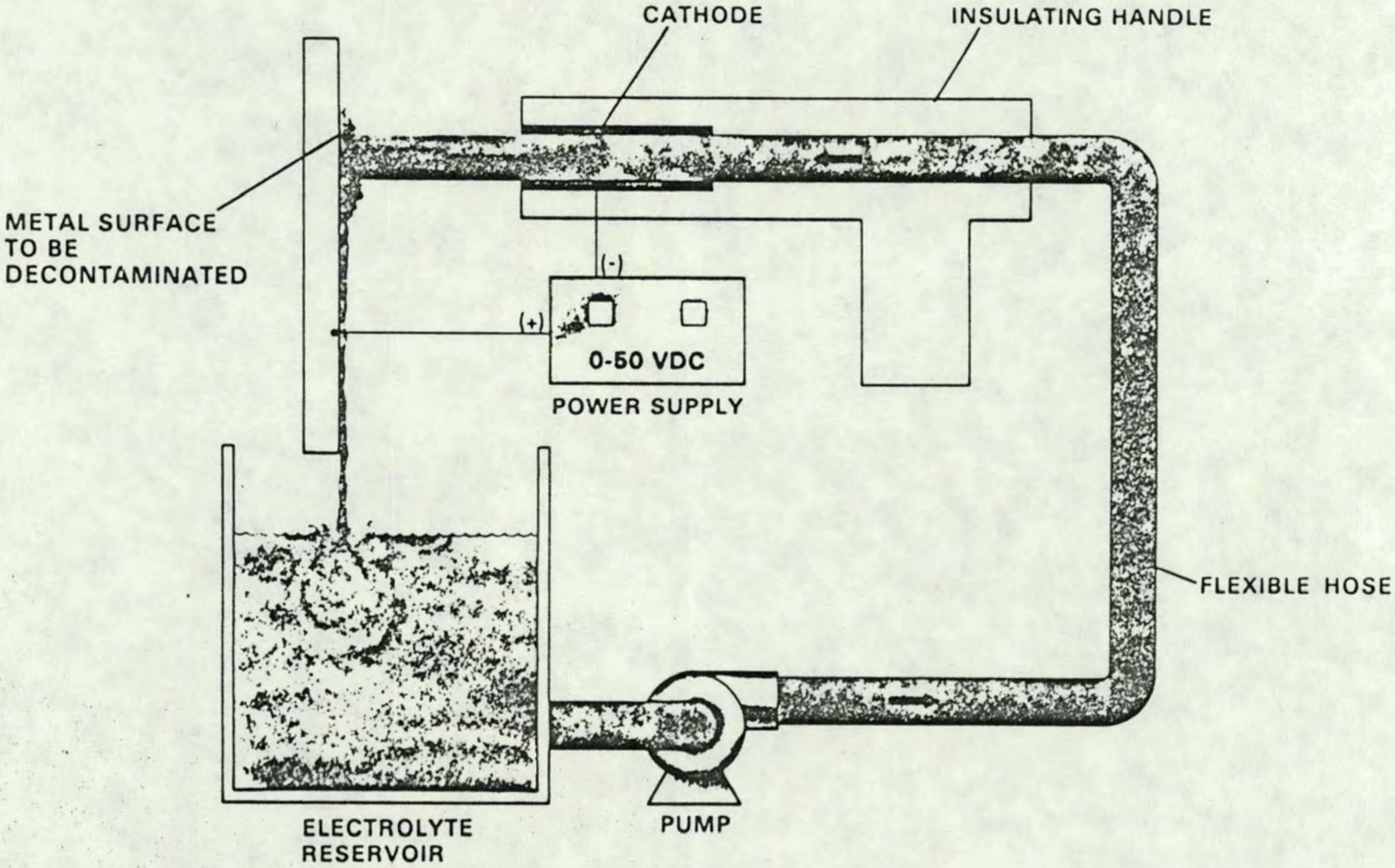
CONTACT TECHNIQUE



FEATURES:

- DECONTAMINATE PLANAR SURFACES
- COMPLETE CONTAINMENT OF ELECTROLYTE
- USEFUL FOR LARGE AREAS

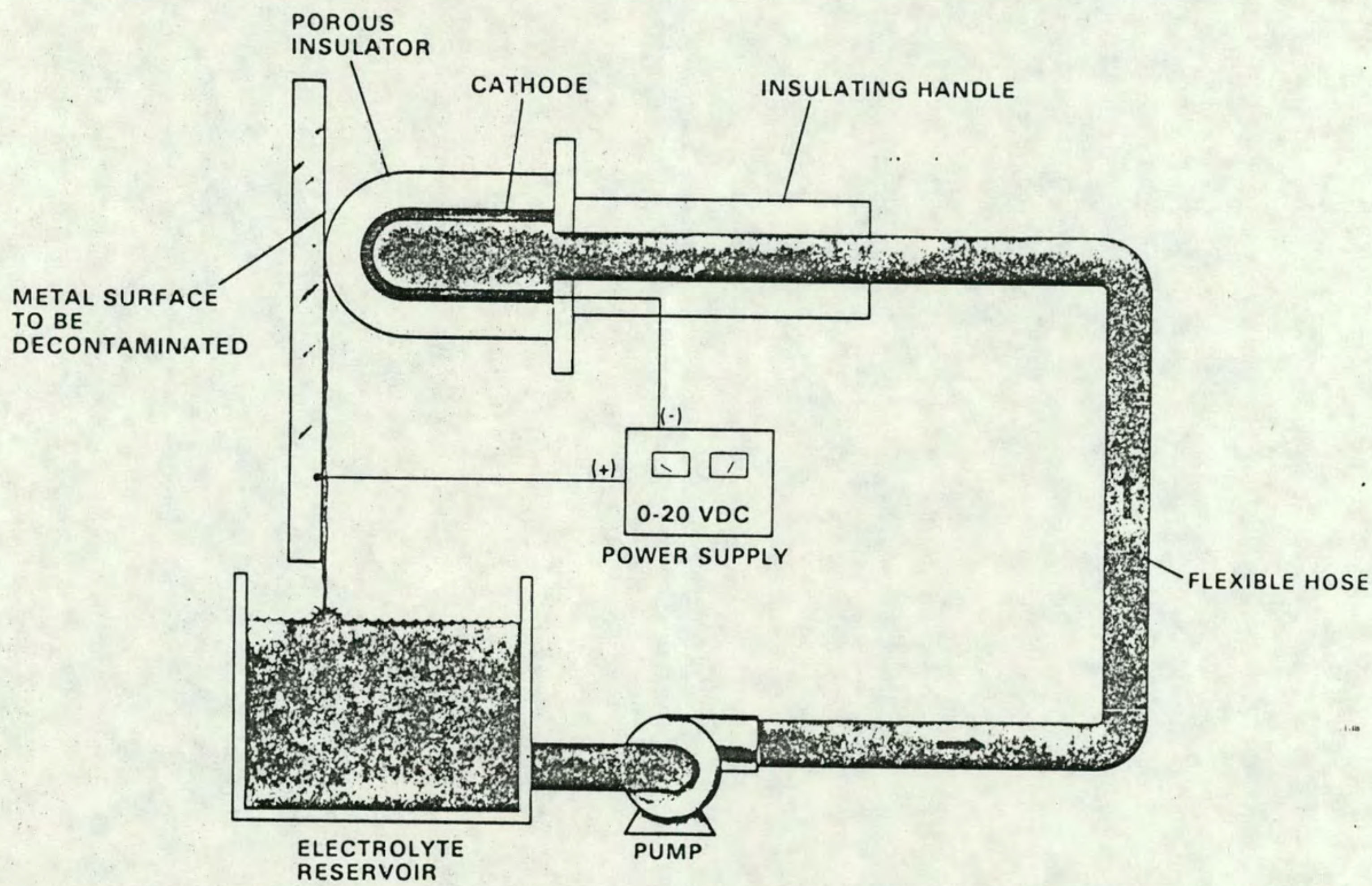
PUMPED STREAM TECHNIQUE



FEATURES:

- DECONTAMINATE IRREGULAR SURFACES WITHOUT CONTACT
- PORTABLE SYSTEM IDEAL FOR FIELD APPLICATIONS
- SPOT DECONTAMINATION

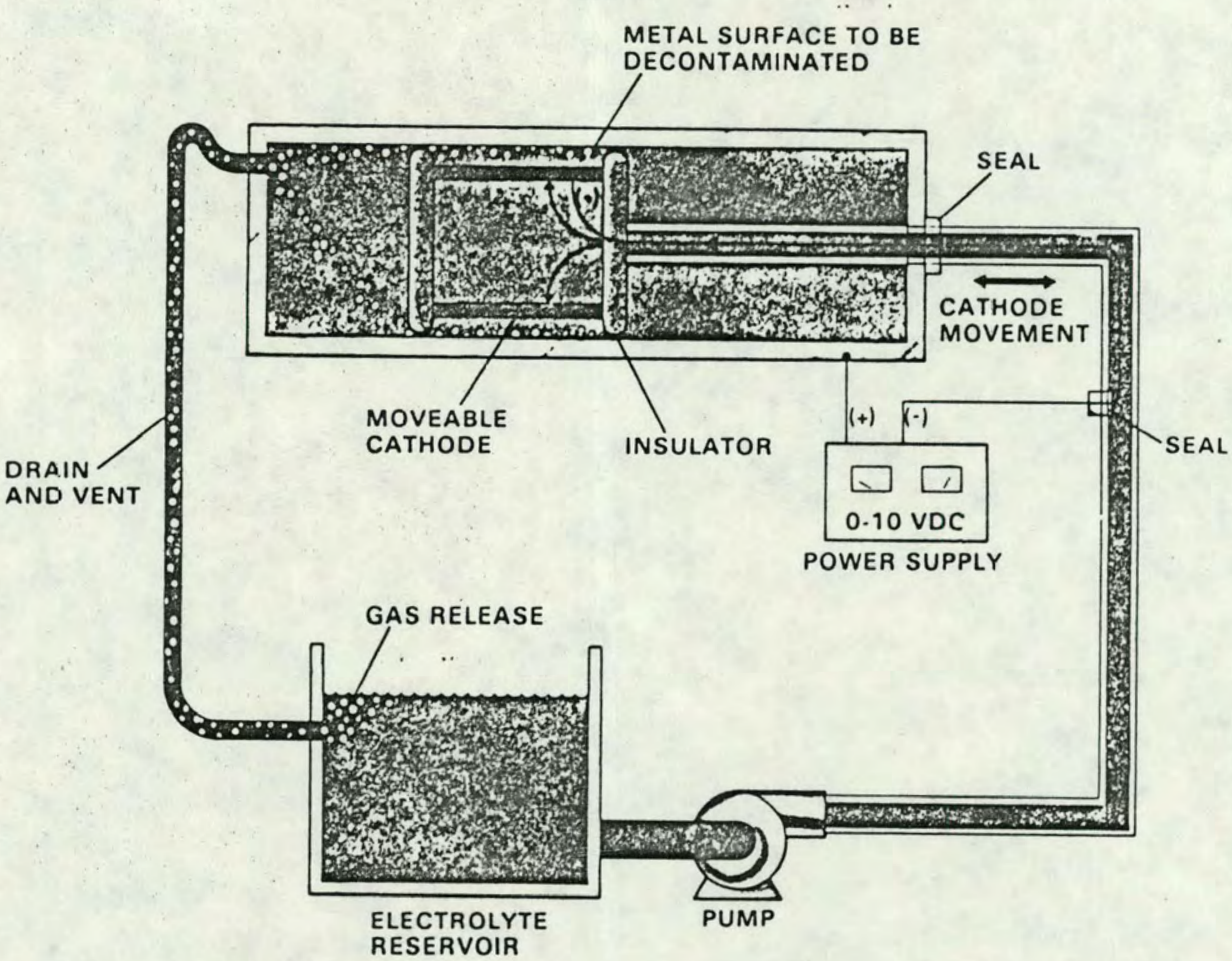
BRUSH TECHNIQUE



FEATURES:

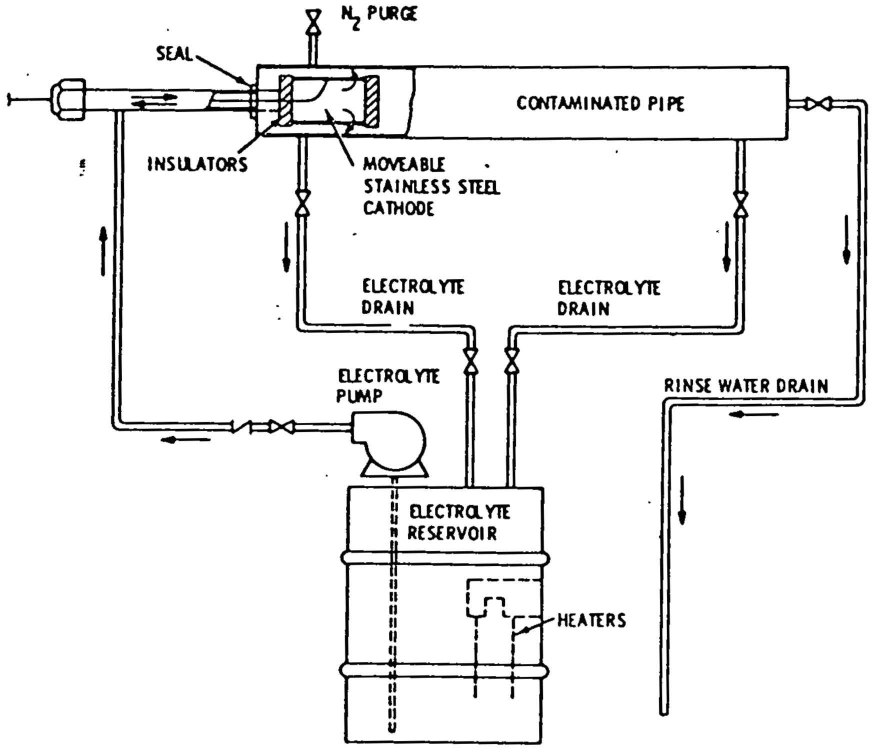
- PRECLEANING
- SPOT DECONTAMINATION

INTERNAL CATHODE TECHNIQUE



FEATURES:

- DECONTAMINATE INTERNAL SURFACES OF PIPE
- DECONTAMINATE LONG LENGTHS
- DECONTAMINATE CURVED SECTIONS



Schematic of the N-Reactor Corrosion Test Loop with Electropolishing Equipment Installed

Discussion

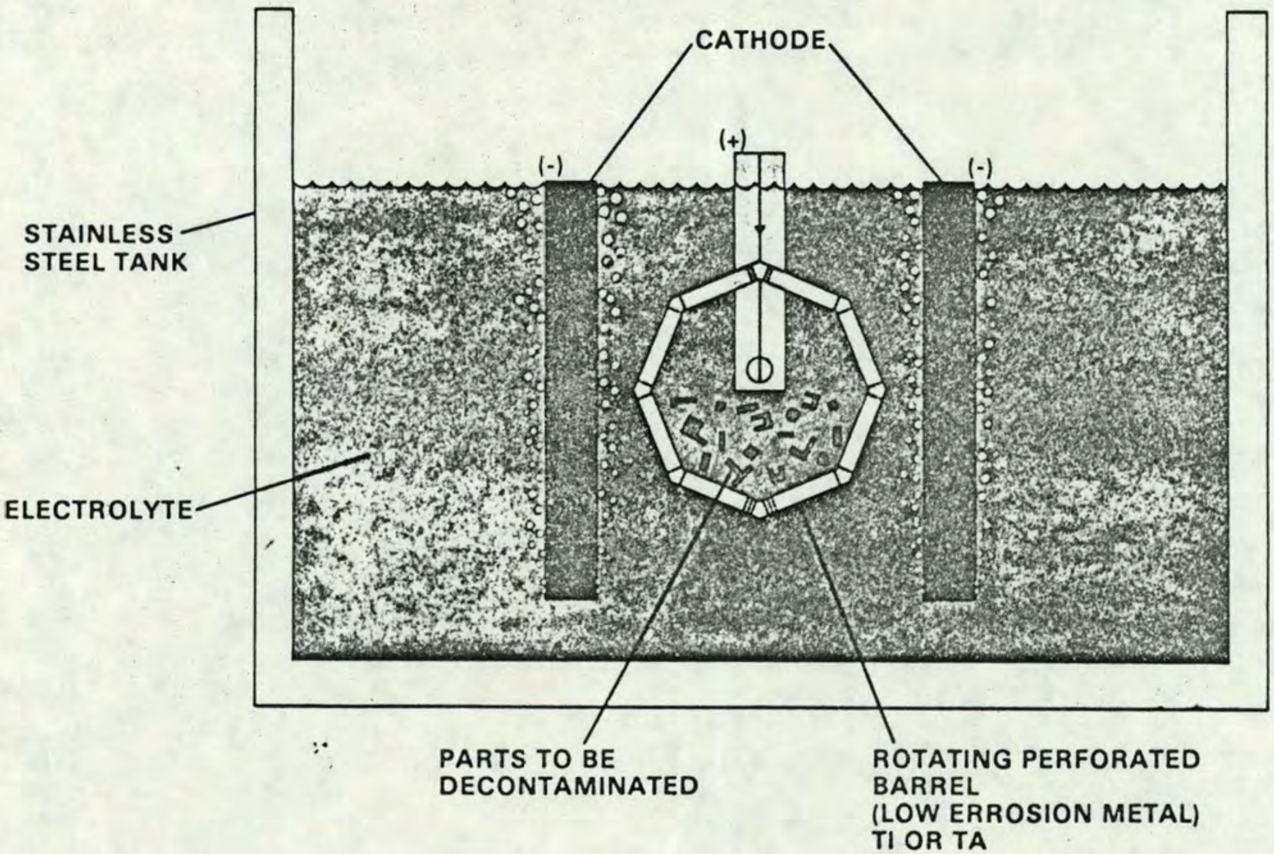
Special electropolishing techniques have been developed for the in situ decontamination of the inside of long pipes. This important application of in situ electropolishing techniques was demonstrated on the corrosion test loop at the Hanford N-Reactor in a test sponsored by United Nuclear Industries, Inc.

The corrosion test loop, which had been in contact with the primary coolant for approximately 15 yr, is a 20-ft-long section of 2.7-in.-I.D. steel pipe. The inside of this pipe was electropolished 2 ft at a time using a movable cathode that consisted of a 2-ft-long, 1-7/8-in.-O.D., stainless steel pipe with nylon insulators at each end. The electrolyte was pumped through the cathode into the pipe, which was isolated from the primary coolant system by valves, and returned to the external electrolyte reservior through a drain line at each end of the loop, the electrolyte was supplied to the cathode through a 20-ft-long PVC pipe that also served to move the cathode and, in addition, contained the electrical cable to the cathode. A standard reactor process tube end cap was modified to allow free passage of the plastic pipe while ensuring containment of the electrolyte.

Each 2-ft section of pipe was electropolished for 20 min at a current of approximately 100 A/ft^2. The hydrogen generated by the electropolishing process was flushed out of the pipe by the circulating (4 gal/min) electrolyte and was vented from the external electrolyte reservior. The measured hydrogen level in the working area was always well below a hazardous concentration. At the conclusion of the electropolishing runs, the electrolyte was removed and the pipe rinsed by pumping water through it. The limited test time did not permit a more adequate internal spray rinse.

The radiation levels inside the pipe before and after electropolishing were measured at 1-ft intervals using a Geiger-Mueller tube. The electropolishing treatment reduced the average radiation levels in the less contaminated portion of the pipe by about 4 R/hr. The readings near pipe fittings, where pockets of contamination had collected, were reduced by more than 40 R/hr. Electrolyte containing corrosion inhibitors was used to minimize corrosion of the pipe by the phosphoric acid. Ultrasonic wall thickness measurements and pressure tests at the conclusion of the decontamination study verified the integrity of the pipe and permitted its return to service.

BARREL ELECTROPOLISHING



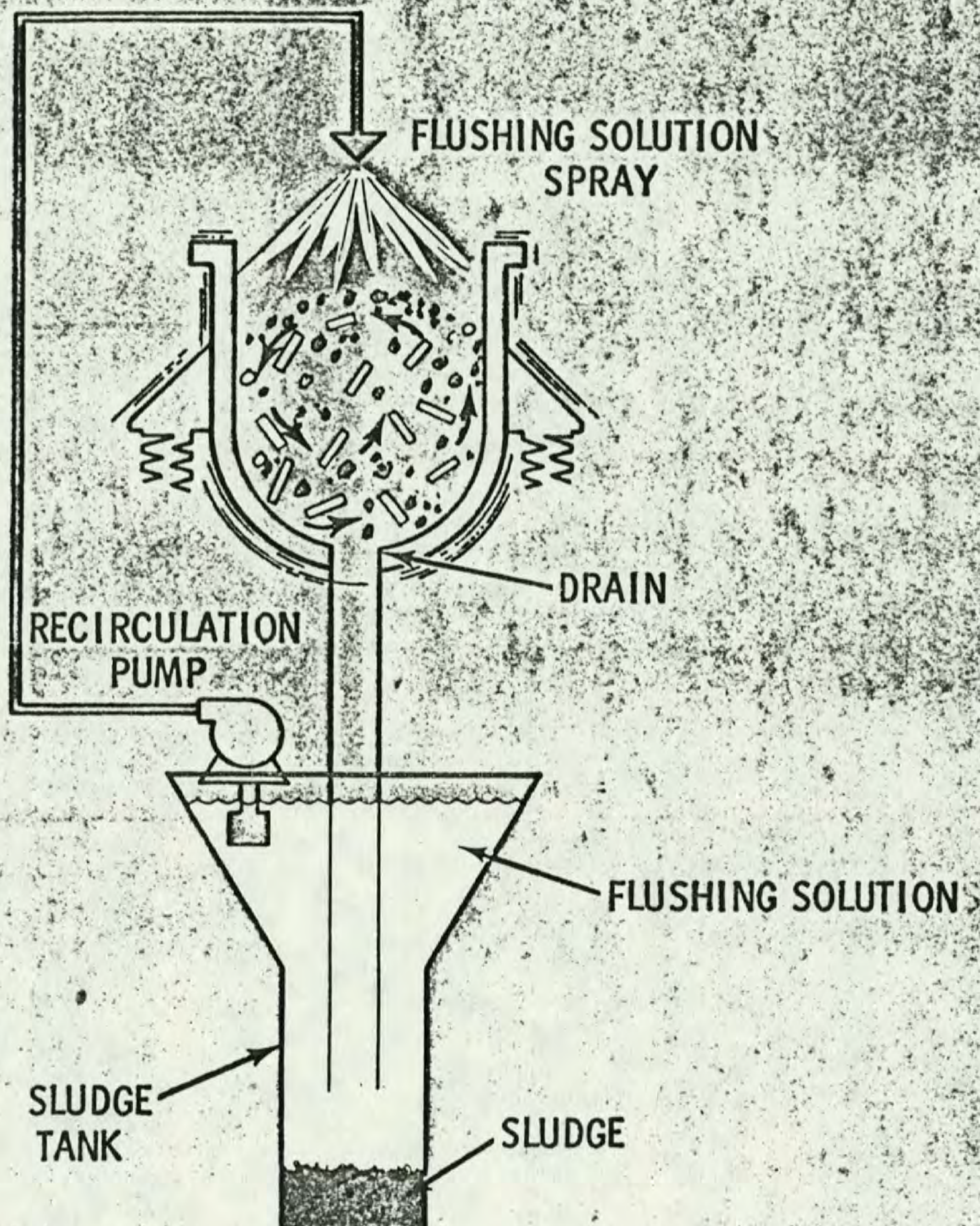
FEATURES:

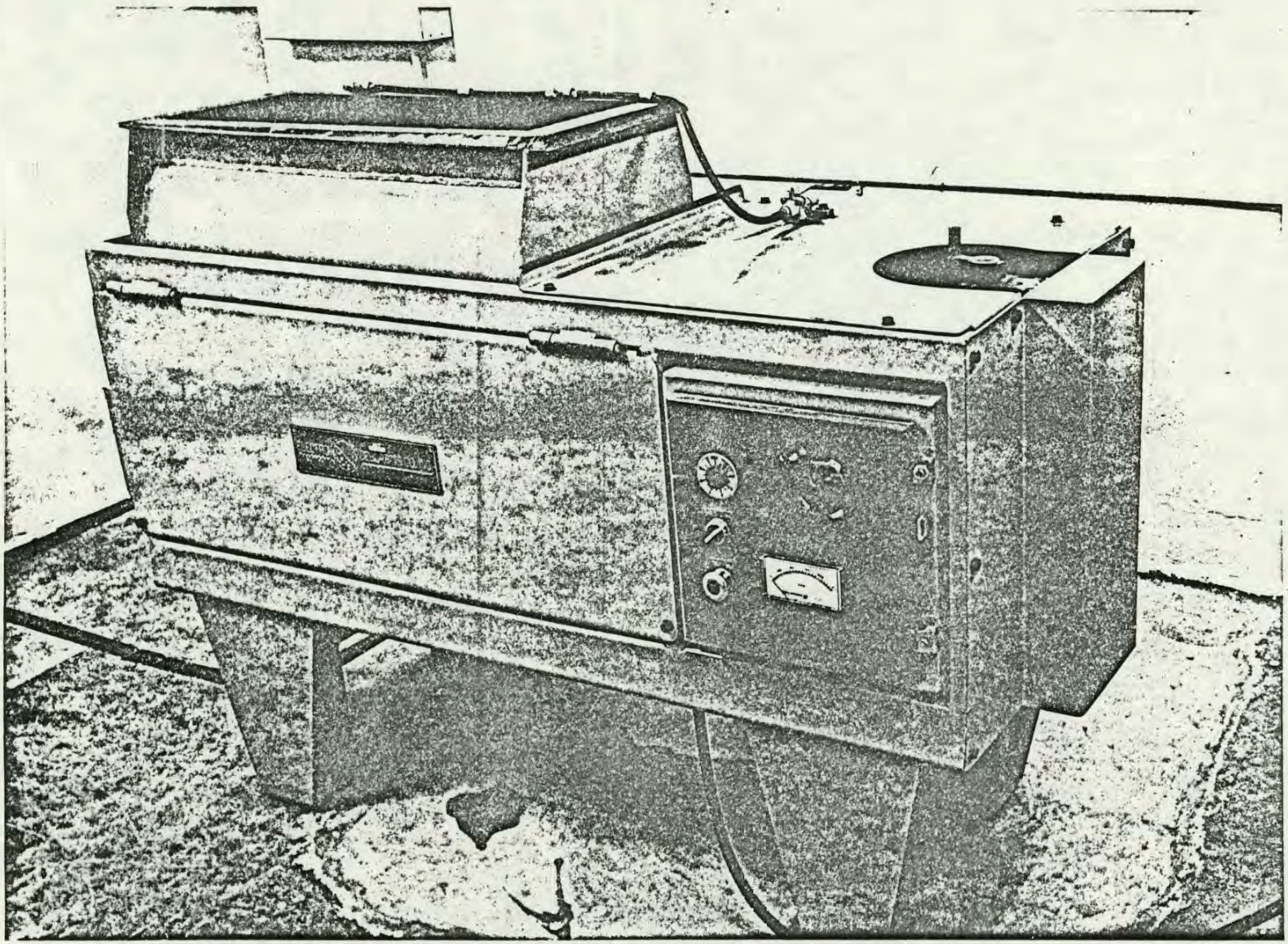
- RACKING OF INDIVIDUAL PARTS ELIMINATED
- REDUCES PROCESSING EXPENSES AND OPERATOR EXPOSURE

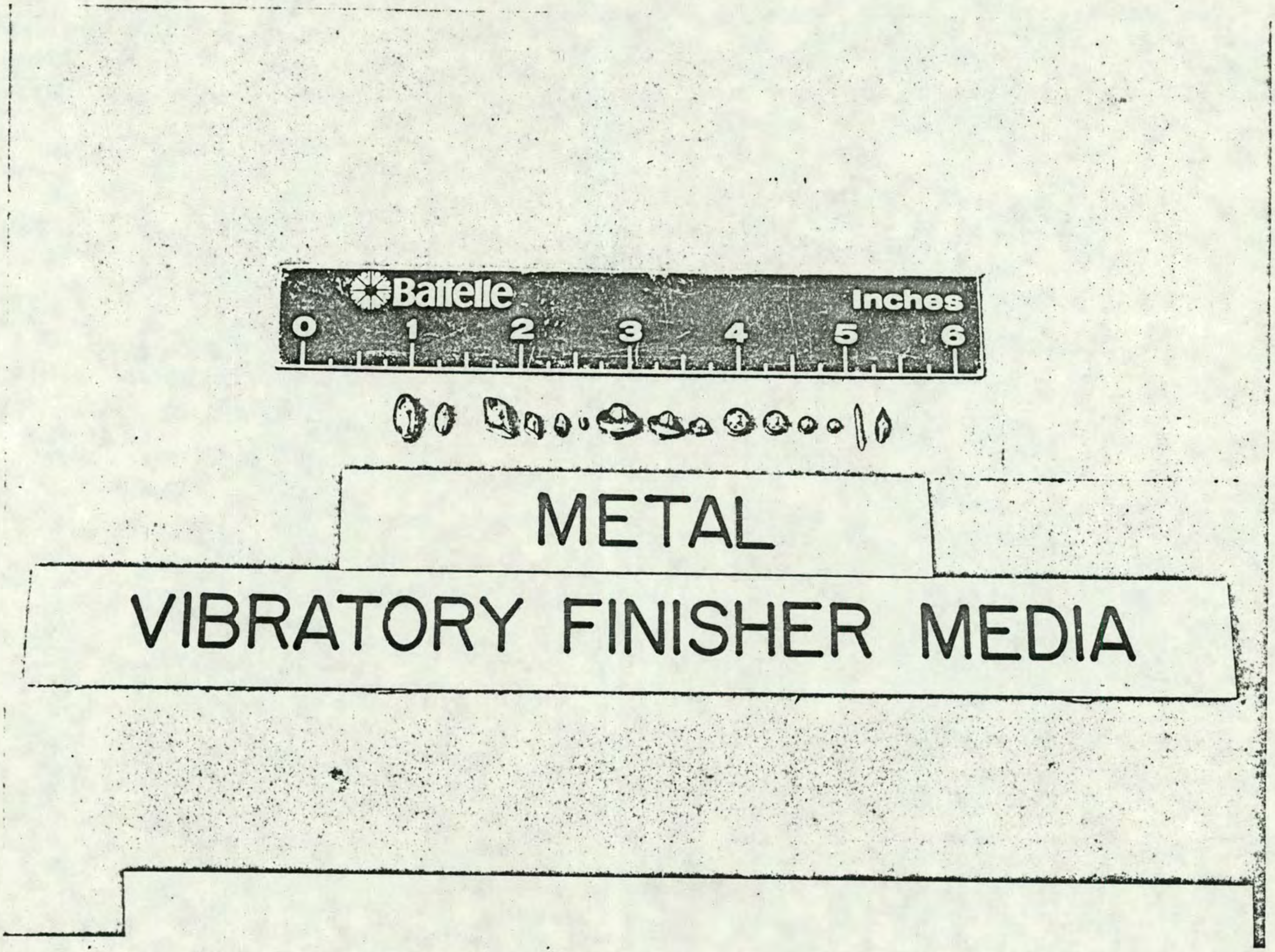
VIBRATORY FINISHING AS A DECONTAMINATION TECHNIQUE

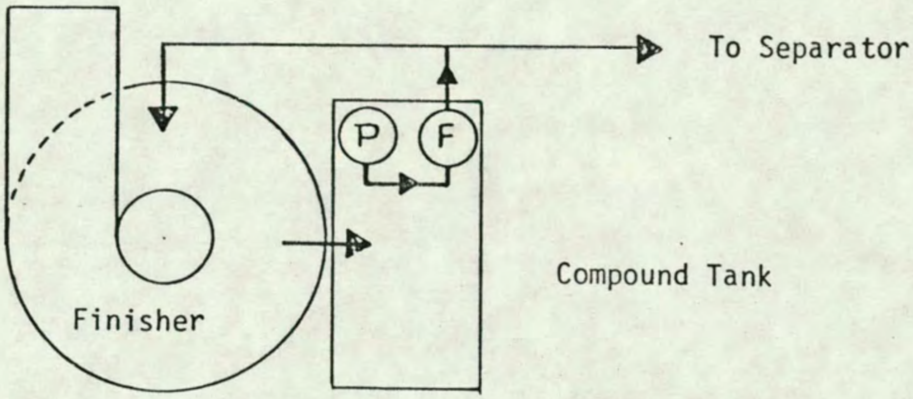
- CAPABLE OF REMOVING GROSS CONTAMINATION
- PRODUCES SURFACES THAT ARE NONSMEARABLE AND IDEAL FOR SUBSEQUENT REUSE OR FINAL DECONTAMINATION BY ELECTROPOLISHING
- CAPABLE OF DECONTAMINATING SELECTED NONMETALLICS SUCH AS HARD RUBBER AND PLASTIC
- USES METALLIC MEDIA THAT PRODUCE ALMOST NO SECONDARY WASTE

VIBRATORY FINISHING SYSTEM

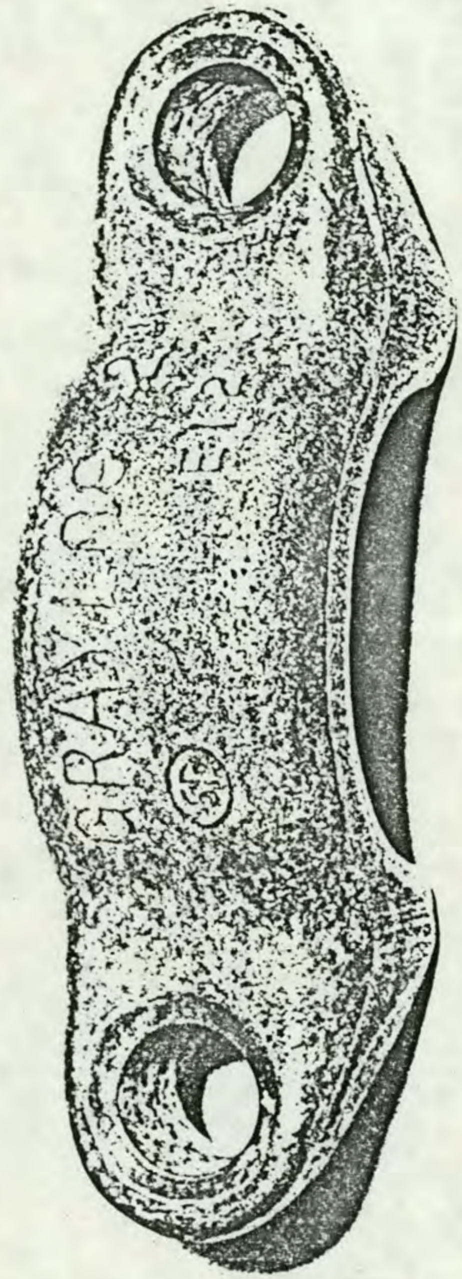




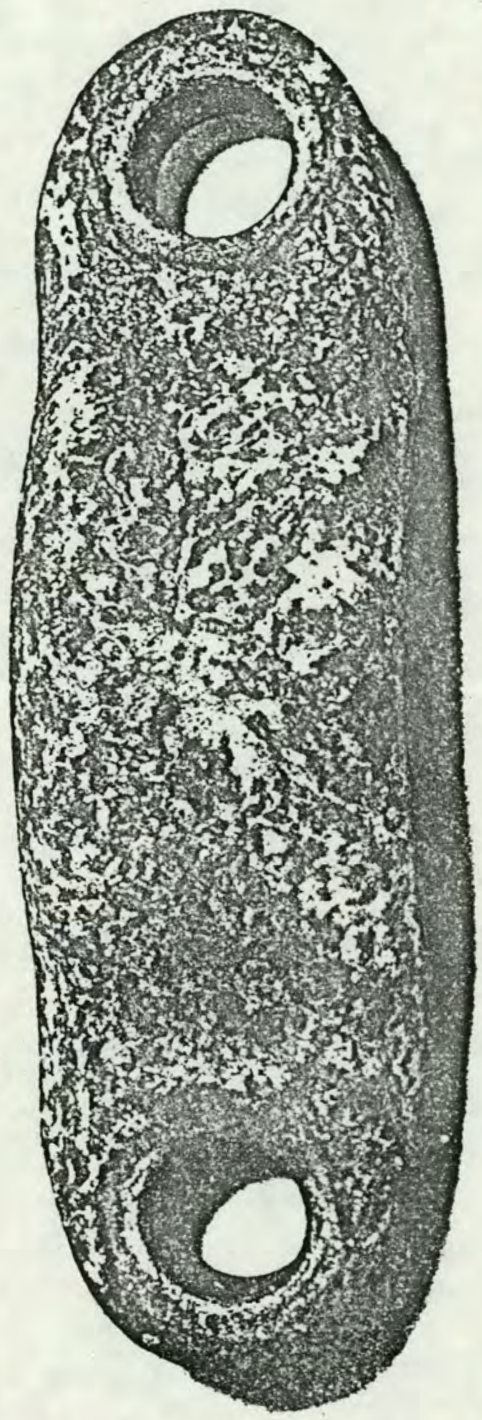

Battelle
Inches
0 1 2 3 4 5 6
METAL
VIBRATORY FINISHER MEDIA



Waste Processing for Vibratory Finishing Process

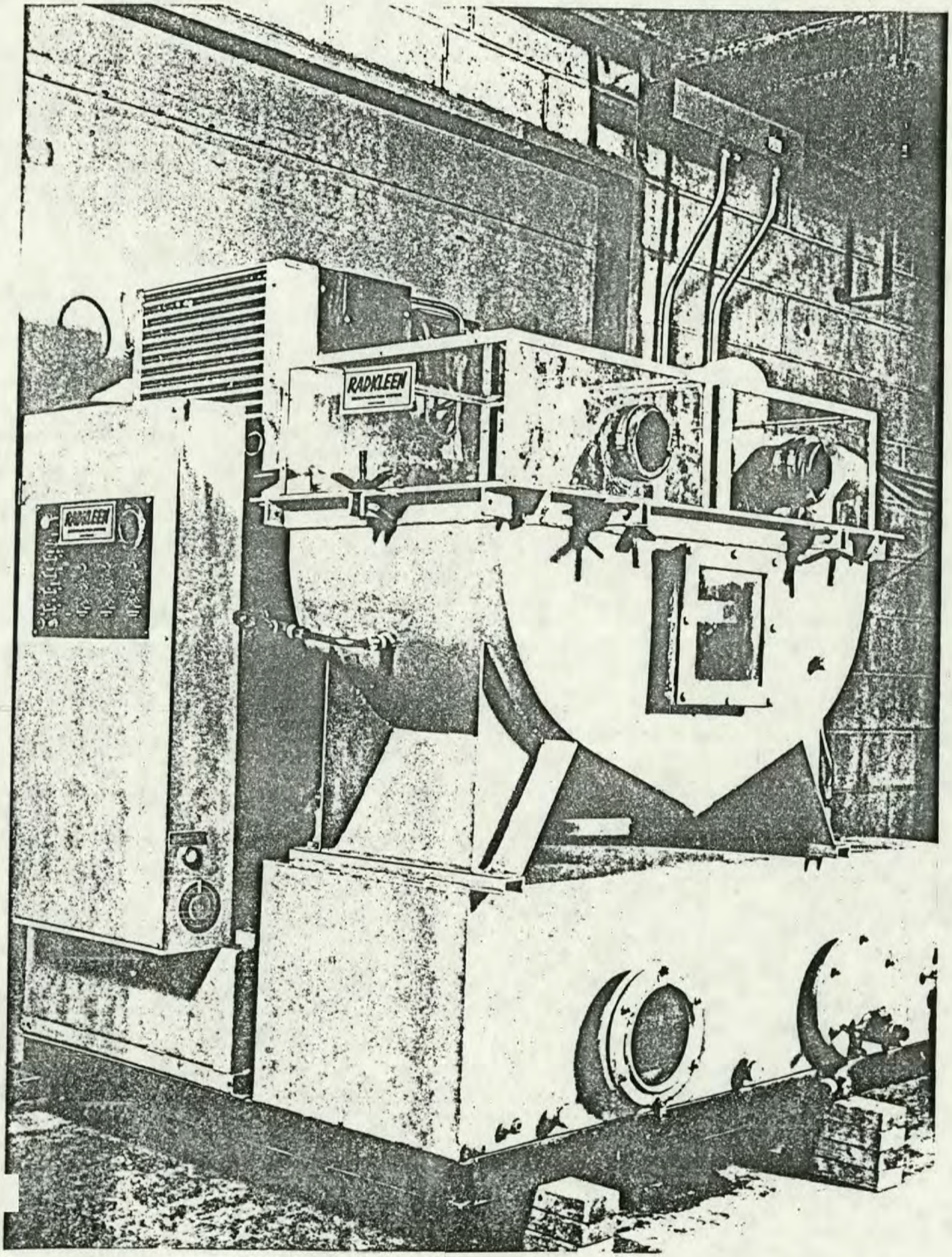


After



Before

Example of Vibratory Finished Components

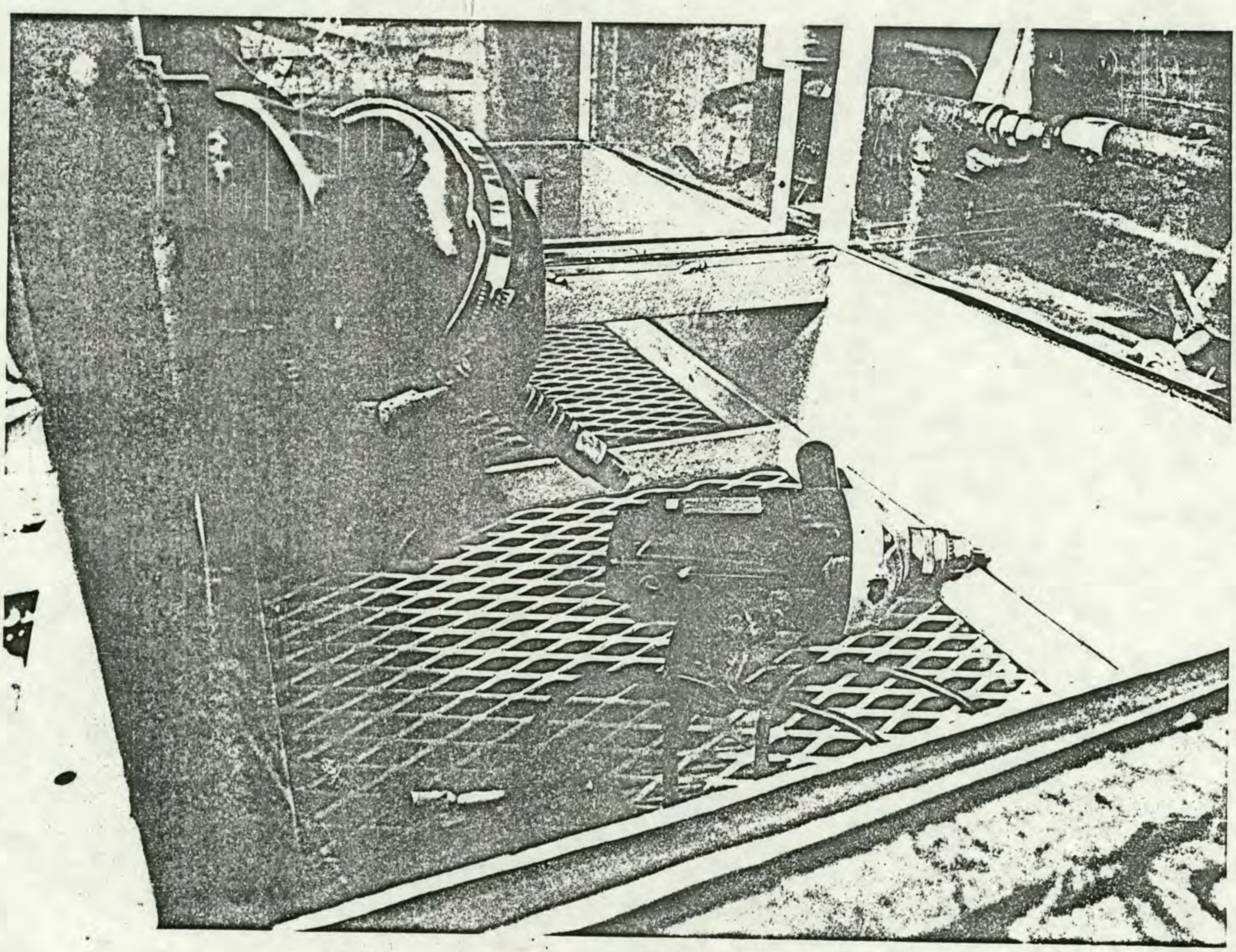

RADKLEEN
RADKLEEN

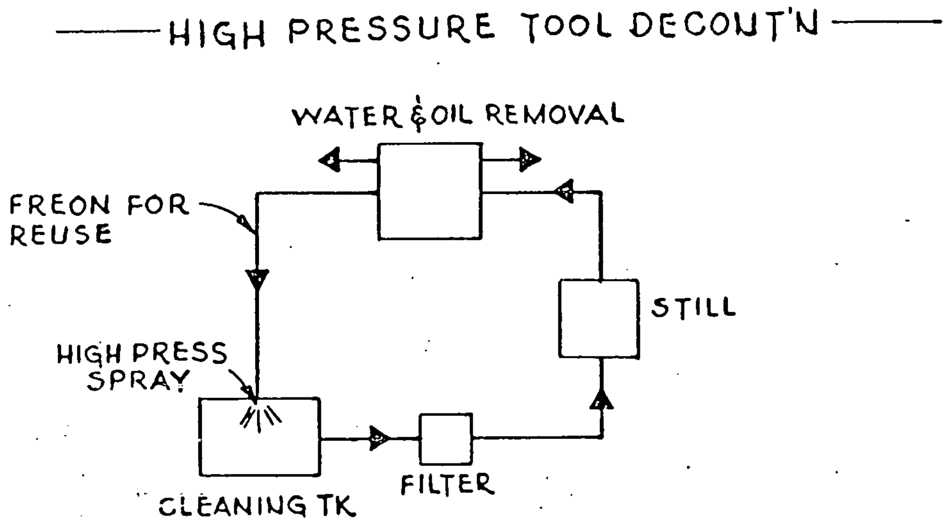
Discussion

High Pressure Freon Tool Decontamination System

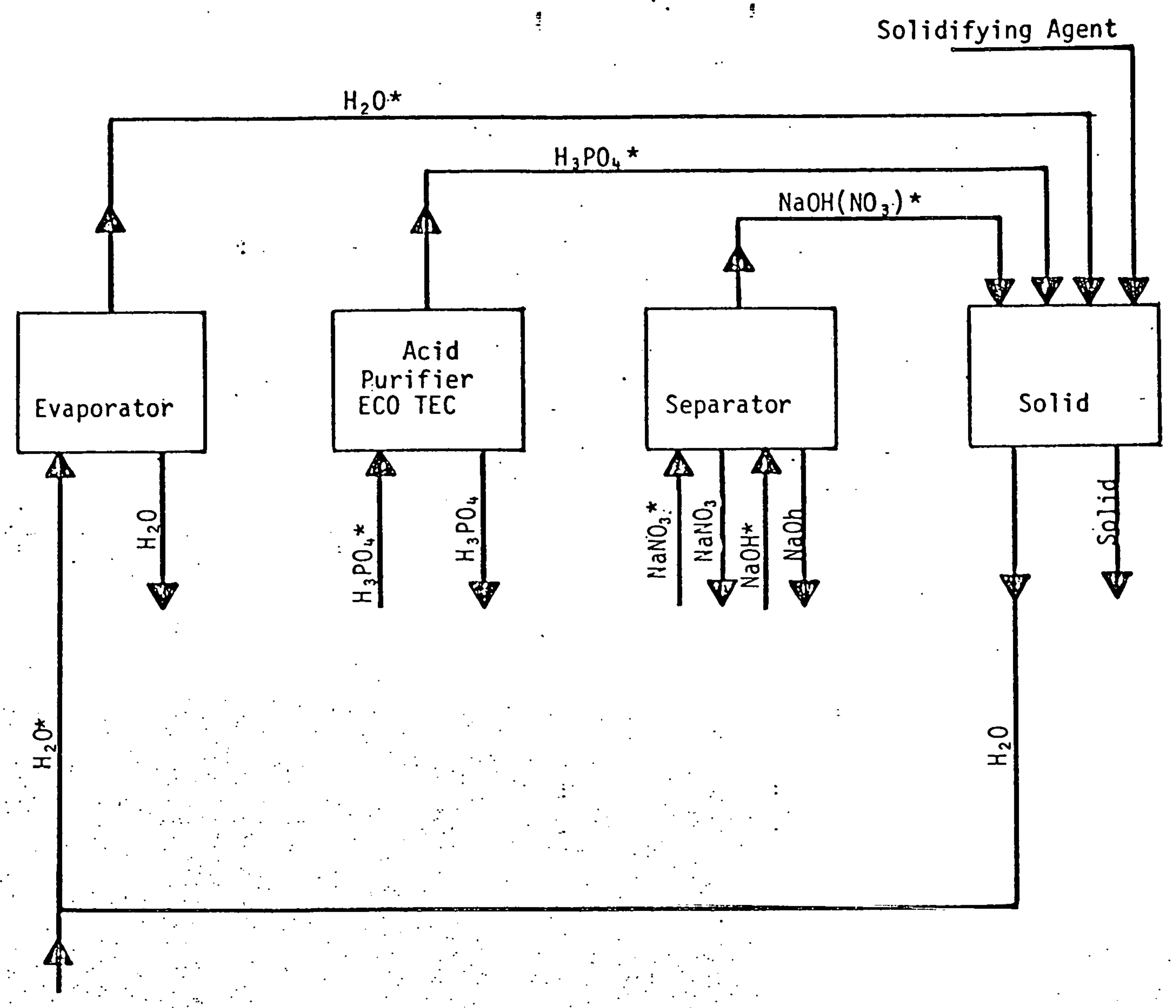
The High Pressure Freon Tool Decontamination unit consists of a cleaning vessel where high pressure freon is sprayed in copious quantities on the contaminated work for a pre-selected time cycle. The used freon along with the removeable radioactive surface contamination and grease is filtered and distilled prior to recycle. Only fixed radioactive contamination will remain. This unit is capable of cleaning tools, respirators, Scott Air pack harnesses, television cables, air supply hoses, wrenches, hammers, motors - drill and small tools, electrical cords, nylong slings and any other small object that can fit in the 2 x 3 x 2 ft work space.

This decontamination system can also be equiped with accessories that can clean electric motors in place, (while operating), electrical cable trays, and may be used as a source of rinse solvent for a vibratory finisher.



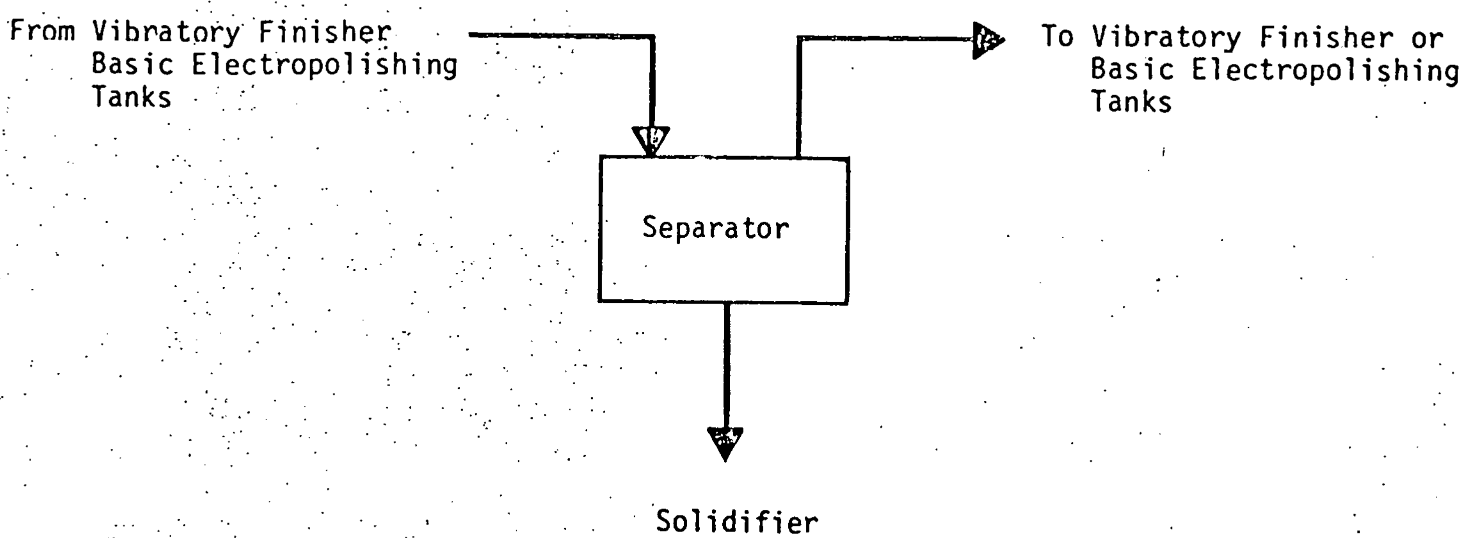


Freon Process Diagram



*With Contamination

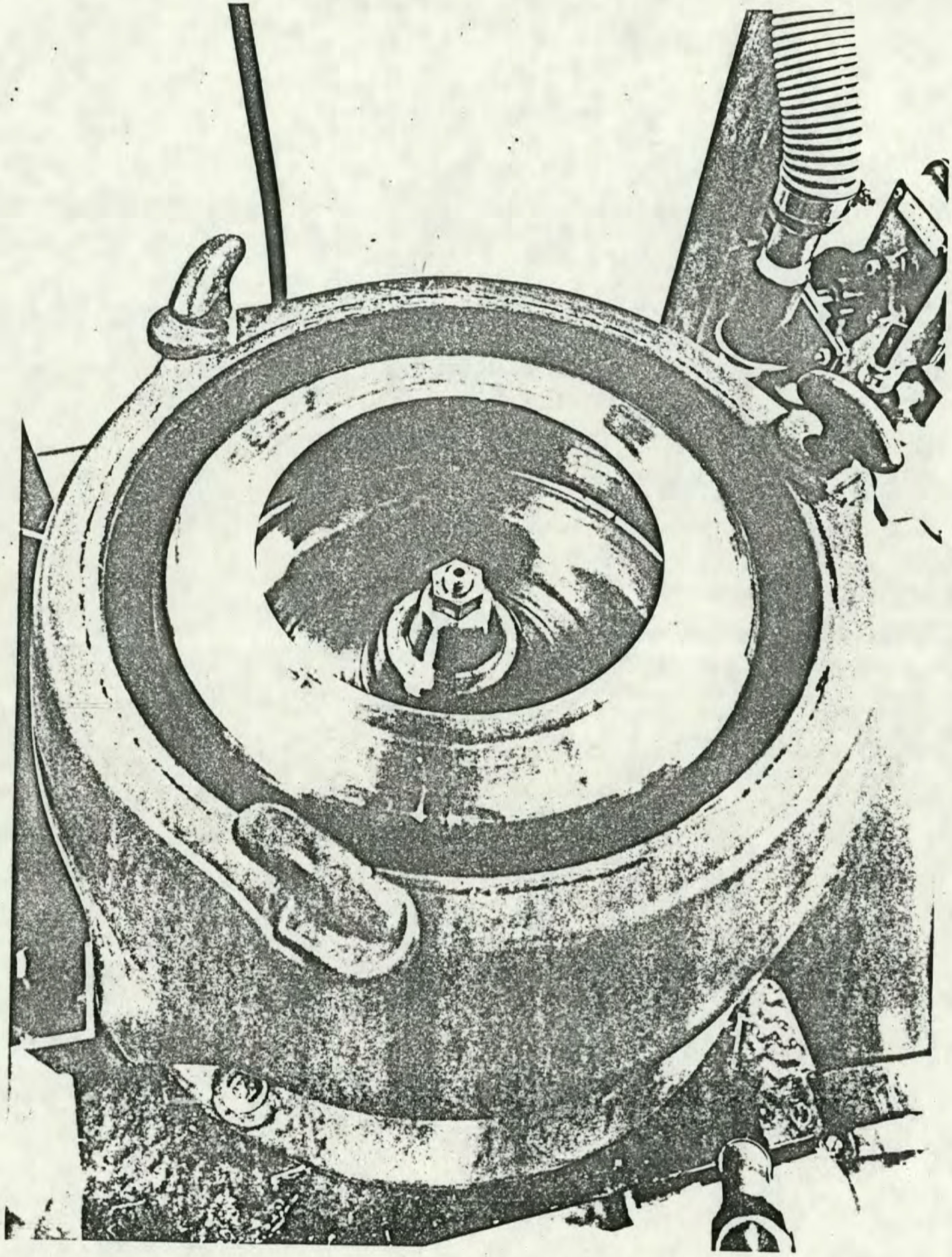
Waste Treatment System Flow Diagram

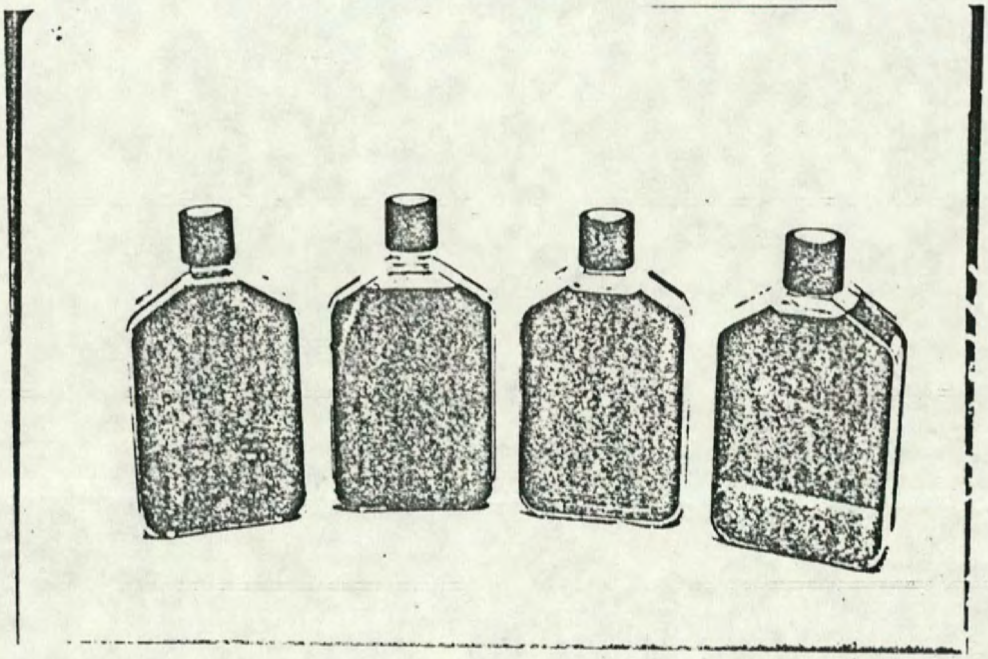

From Vibratory Finisher Basic Electropolishing Tanks
To Vibratory Finisher or Basic Electropolishing Tanks
Separator
Solidifier

Discussion

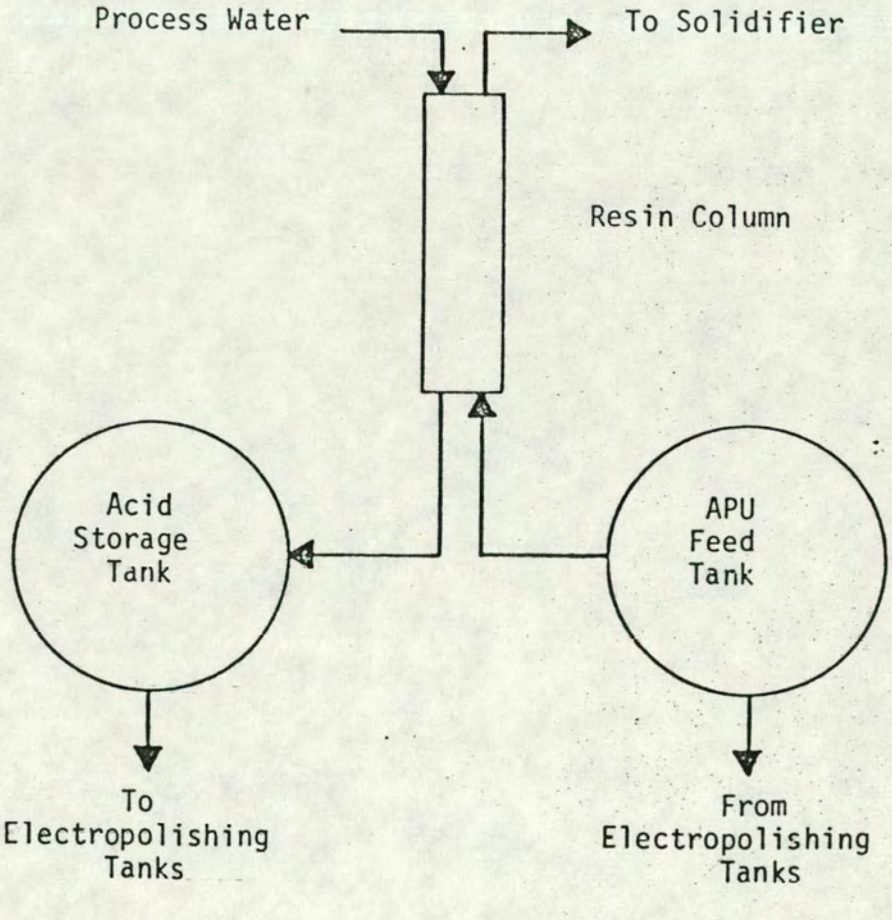
Centrifuge

The separator unit will be used to treat liquid wastes from the Basic Electropolishing Tanks and Vibratory Finisher containing large volumes of suspended solids. The solid phase will be separated from the liquid phase by centrifugation and sent to the solidifier for final processing. The liquid phase will be stored for reuse. The separator system will consist of the separator unit, separator feed tank and processed liquid storage tank. The system will be housed in a shielded containment enclosure.





Clarification of Electrolytes using the Centrifuge

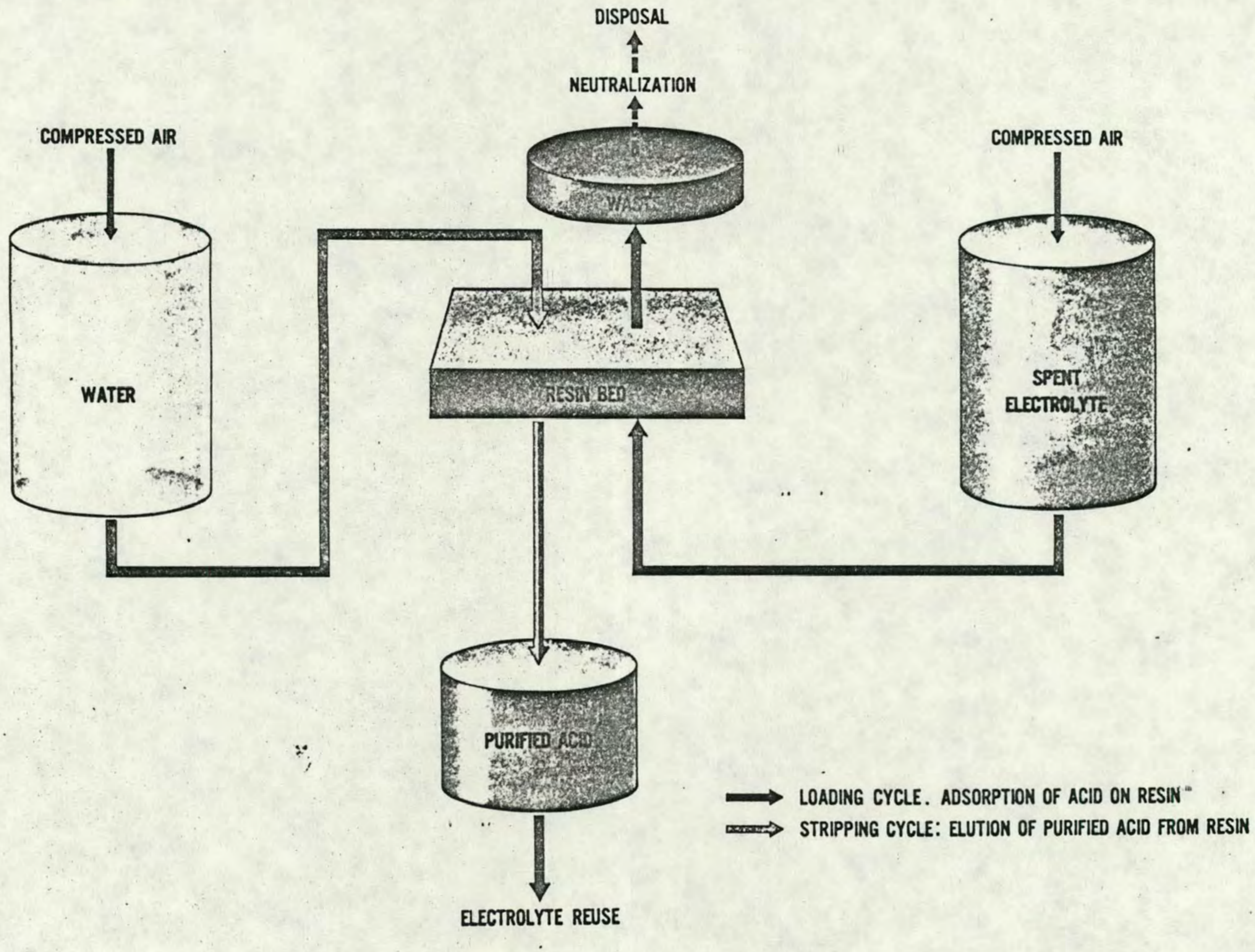

Process Water
To Solidifier
Resin Column
Acid Storage Tank
APU Feed Tank
To Electropolishing Tanks
From Electropolishing Tanks

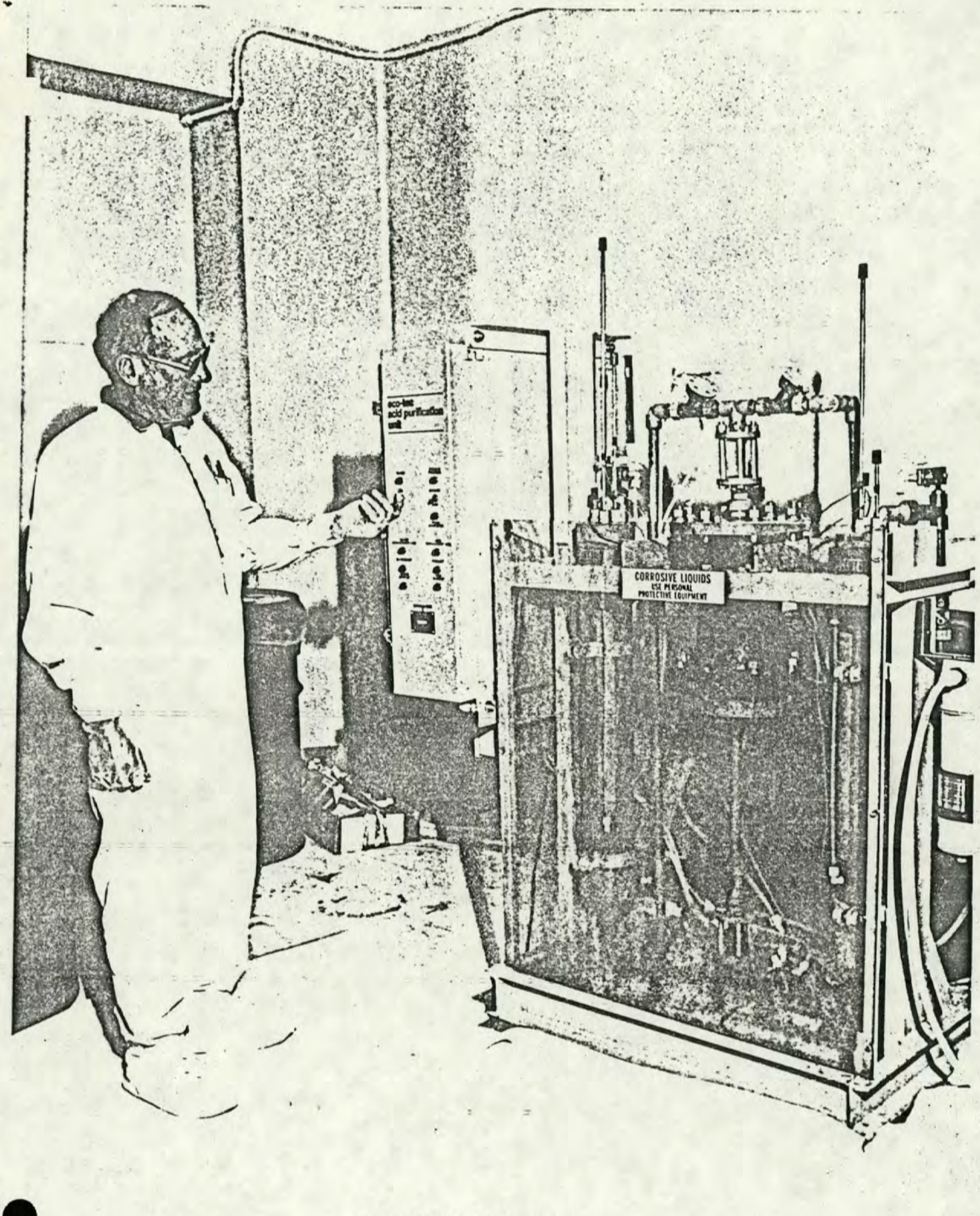
Discussion

Acid Purifier - ECO TEC

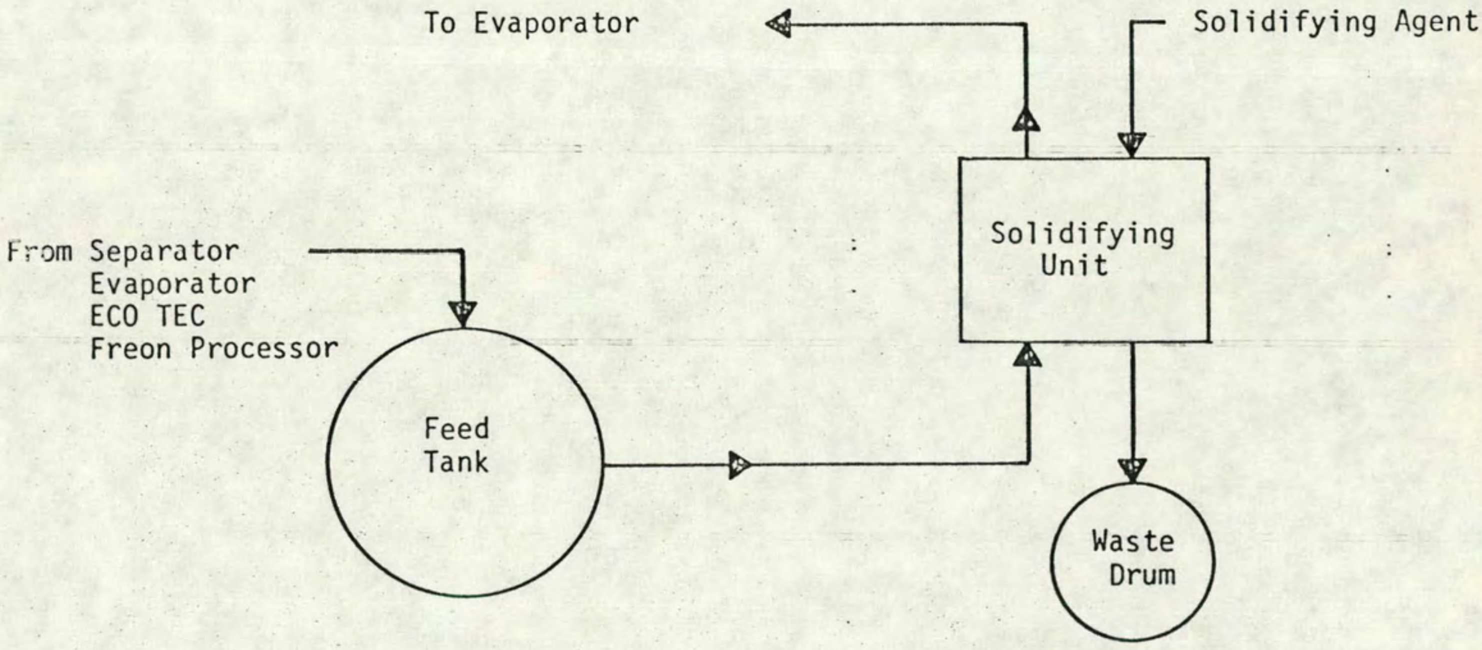
The ECO TEC is an acid absorption purification process. The spent phosphoric acid is forced through a column containing a proprietary ion exchange resin. The phosphoric acid is preferentially adsorbed, allowing the dissolved impurities to pass through the column. The purified acid is then recovered by using water as the elutant. The solution containing the impurities is then solidified in the solidifier. The ECO TEC system is composed of the acid purification unit, a feed tank and an acid storage tank. The system is housed in a shielded containment enclosure.

SPENT ELECTROLYTE PURIFICATION BY RECIPROCATING ACID ADSORPTION





ECO TEC Acid Processor

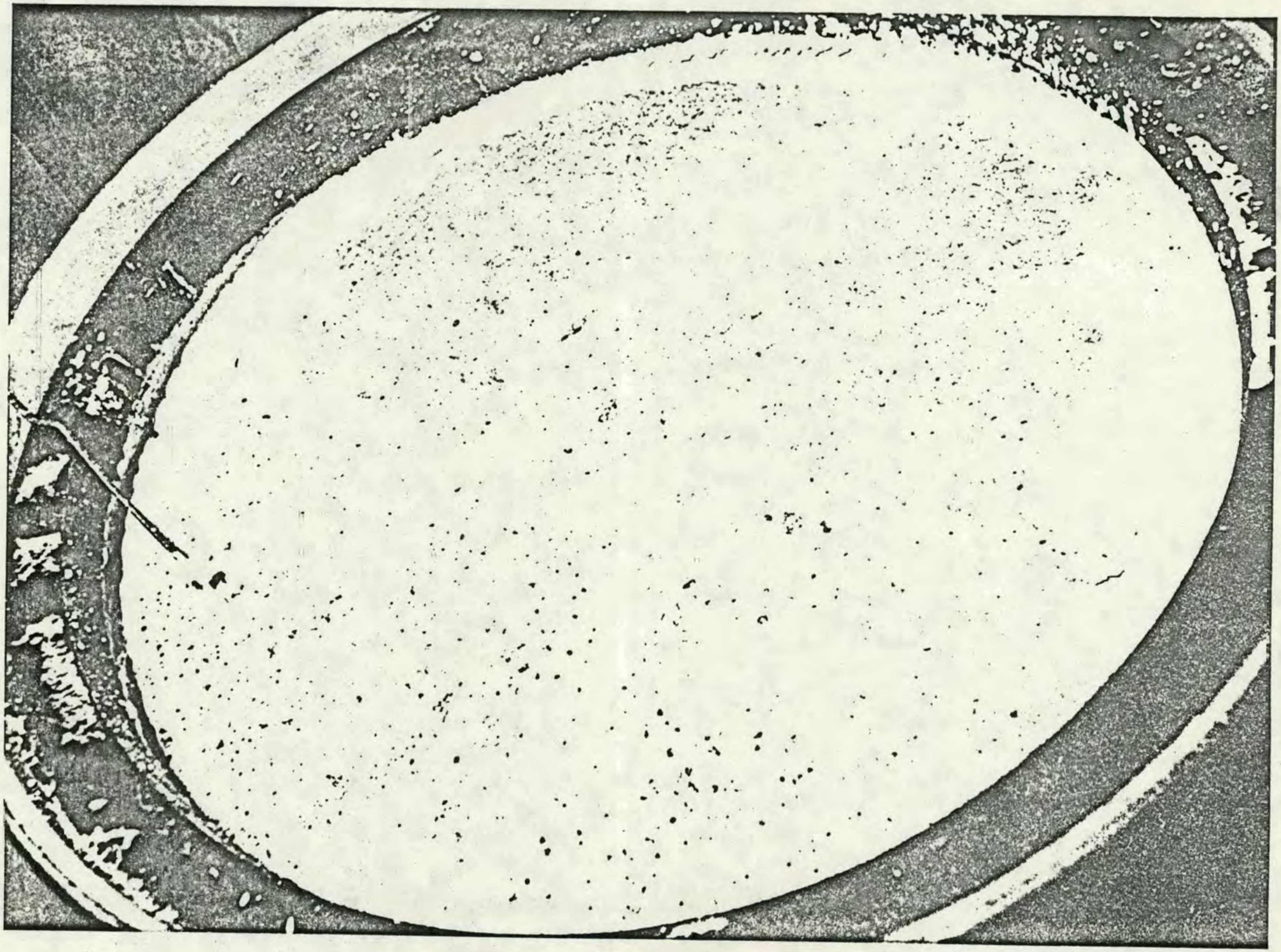


To Evaporator
Solidifying Agent
Solidifying Unit
From Separator
Evaporator
ECO TEC
Freon Processor
Feed Tank
Waste Drum

Discussion

Solidifier

The solidifier unit will complete solidification of wastes processed by other units of the waste treatment facility. The waste will be mixed with a solidifying agent and placed in a steel drum for final curing. Any liquid removed during the process will be processed in the evaporator. The solidifier system will consist of the solidifying unit and a feed tank. The system will be housed in a shielded containment enclosure.



Solidified Phosphoric Acid