

FINAL REPORT

MERCURY CONTROL TECHNOLOGY ASSESSMENT STUDY

Cosan Chemical Corporation
Carlstadt, New Jersey

Preliminary Survey Report
for the Site Visit of
July 16, 1981

Contract No. 210-81-7107

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Foreword

A Control Technology Assessment (CTA) team consisting of members of the National Institute for Occupational Safety and Health (NIOSH) and Enviro Control Inc. (ECI) met with representatives of the Cosan Chemical Corporation in Carlstadt, New Jersey on July 16, 1981 to conduct a preliminary survey on the techniques used to control worker exposure to mercury. Participants in the survey were:

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The preliminary CTA was completed in one day. The study included a process tour and a review of mercury controls.

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I. INTRODUCTION

A. Contract Background

The Mercury Control Technology Assessment Study has been initiated to assess the current technology used to protect the worker from exposure to mercury. The objective is to identify and evaluate the exemplary methods employed by industries in controlling worker exposure to elemental mercury and mercury compounds. A result of the study will be the publication of a comprehensive document describing the most effective means of controlling emissions and exposures. This report will be made available to companies which handle mercury so as to transfer technology within the major mercury using industries. The study will also identify areas where additional research is necessary.

B. Justification for Preliminary Survey

Preliminary surveys are intended to generate information about the control strategies used at various facilities and will be used to determine where in-depth surveys will be conducted. The Cosan Chemical Corporation plant was selected for a preliminary site visit because of the integrated monitoring programs and engineering controls currently in use.

C. Summary of Information Obtained

An opening meeting was held during which the objectives of the program were discussed with the Cosan representatives. The process was reviewed briefly and a tour of the production facility was made. Engineering control details, work practices, and the biological monitoring program were reviewed.

II. PLANT DESCRIPTION

The Cosan Chemical Corporation manufactures additives for the paint and coatings industry and catalysts for the plastics industry. The paint additives are fungicides and bactericides which contain phenyl mercuric acetate (PMA). Cosan has manufactured these products for 17 years, 7 of which have been at the Carlstadt plant. The Cosan facility consists of an executive office building, an engineering, research and development building, and 2 production plants. One of the plants (Building #5, PMA plant) houses all the operations involving mercury (Figure 1). Building #5 covers approximately one third of an acre and is constructed of block wall with a wood roof. The interior of the plant has been continuously renovated section by section to accommodate new process equipment and mercury controls.

Cosan employs a total of 50 people, 14 of whom work in the PMA plant. These 14 workers' job classifications are as follows:

- 6 class A workers
- 3 class B workers
- 3 class C workers (utility)
- 2 maintenance workers

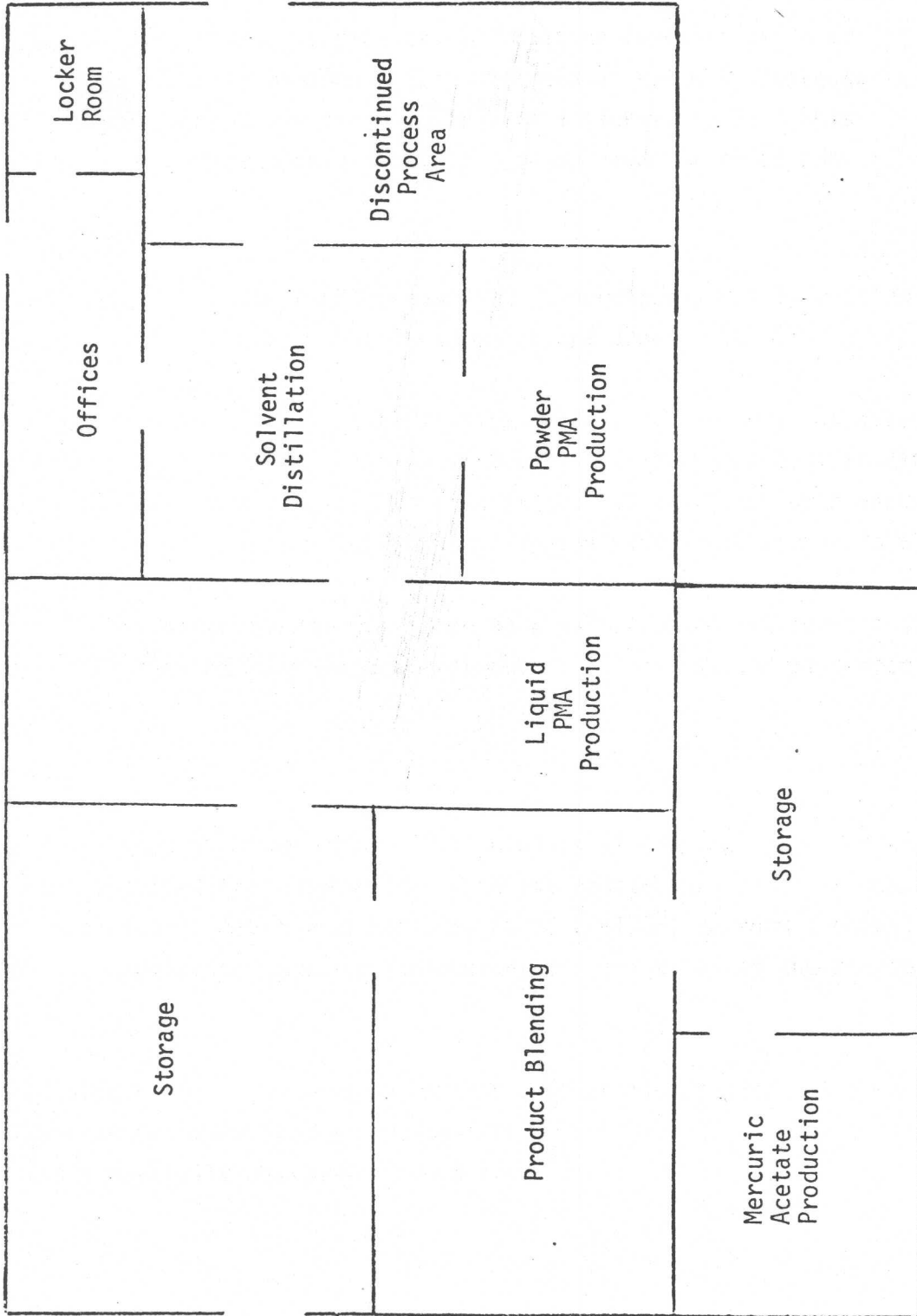


Figure 1. PMA Plant Layout (not drawn to scale)

III. PROCESS DESCRIPTION (Figure 2)

Phenyl mercuric acetate is produced by reacting mercuric oxide or mercuric acetate with benzene and acetic acid at reflux. Solvents in the resulting product are stripped leaving a slurry of PMA. This slurry can be used to make either a liquid or powder form of PMA.

1. Raw Material Procurement

Mercuric oxide for use in PMA production is purchased from an outside vendor in 50 pound plastic bag lined cardboard drums.

Mercuric acetate is manufactured on-site. Elemental mercury purchased from Placer-Amex is transported in 2200 pound super flasks by fork truck to the mercury addition area. It is drawn out of the flask by a vacuum pump and into storage tanks. From the storage tank it is pumped to a head tank located above a 1500 gallon stainless steel reactor. The reactor is charged with mercury by opening a valve. Mercuric acetate is produced in this reactor through a proprietary process, and is pumped to storage tanks.

2. PMA Production

PMA is produced at Cosan in 2000 gallon glass lined reactors. Mercuric acetate is pumped from storage tanks to the reactors where it is combined with benzene and acetic acid refluxed at 80 C (176F) to form a phenyl compound. Additional benzene and acetic acid are added to the reactor as needed.

If mercuric oxide is to be used instead of mercuric acetate, it is added to the reactors manually by emptying fifty pound bags into a manhole through a specially designed exhaust hood.

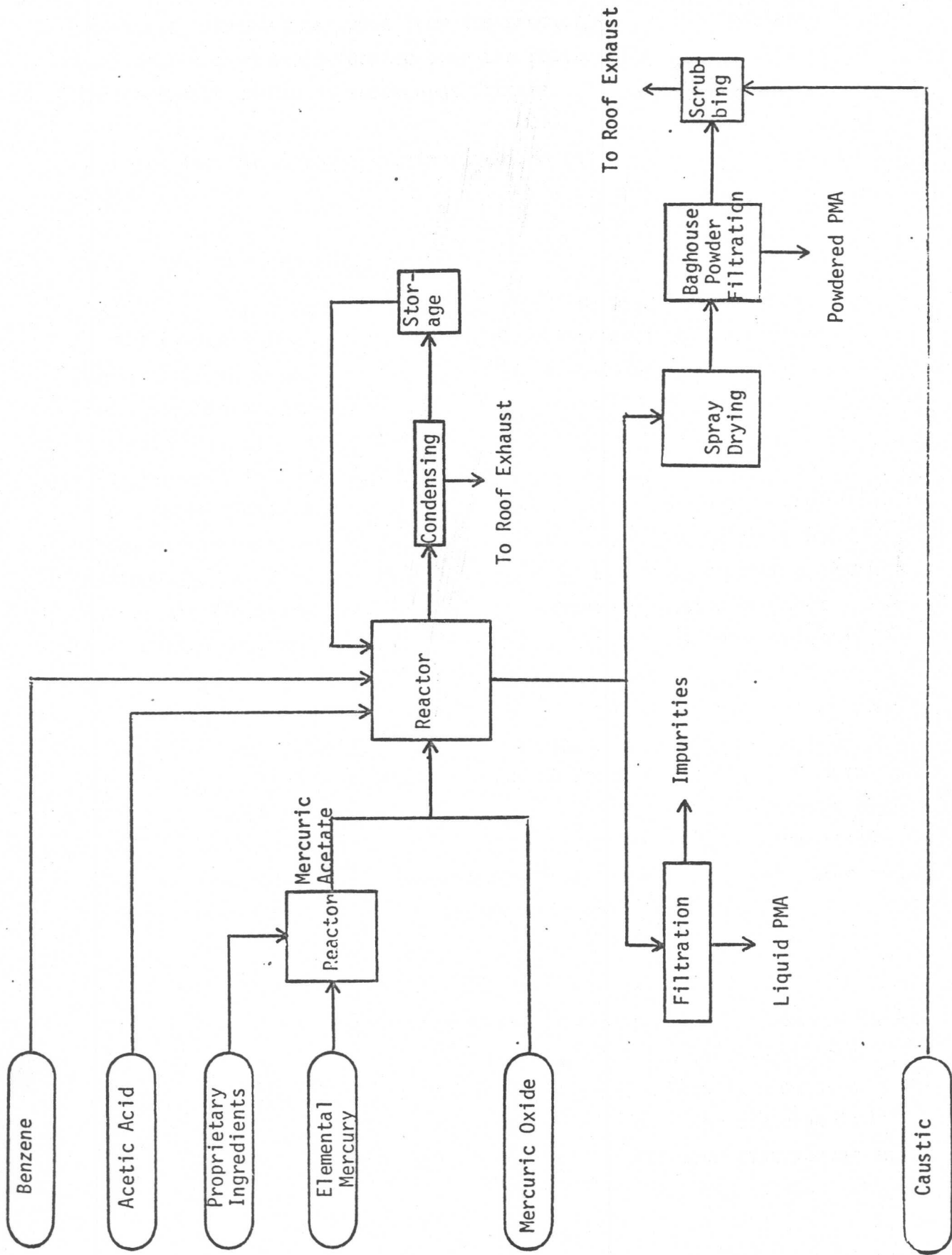


Figure 2. PMA Manufacturing Process Flow Diagram

The excess solvents, stripped from the product in the reactor, are reclaimed in condensers located over the reactors, and are pumped to storage tanks for use in subsequent batches.

The resulting PMA slurry is further refined into either a powder or a liquid.

3. Product Refinement

a. powder: A powder product is manufactured by spray drying the PMA slurry. Dried powder from the spray drier is separated from the air flow in a 36 bag Mikro Pul Model 36S-8-30 baghouse. Air and powder are blown through 6 sets of six 16-ounce NOMEX fabric bags. The bags have wire mesh cages inside of them to keep them from collapsing. A Pulsair unit in the baghouse blows the powder down from the bags. An automatic timed knocker is used to shake the powder down to the bottom of the baghouse into a rotary valve. The rotary valve turns continuously releasing the PMA powder through a drop chute into a drum below. Air flow from the baghouse passes through a caustic scrubber which controls acetic acid emissions and prevents accidental release of PMA into the air stream in the event of bag breakthrough..

b. liquid: Liquid is manufactured by mixing the PMA with low molecular weight glycol and adding ammonia to raise the pH to 8. The resulting liquid is an ammonium complex containing approximately 30% PMA, 20% alcohol, 25% ammonium acetate, and 25% water. Impurities which may contain mercury are removed from the liquid in a ventilated filter press and the product is stored in 55 gallon drums.

4. Dilute Product Blending

A fine textured, more dilute form of PMA is also produced at Cosan. This product is manufactured by blending powdered PMA with calcium silicate to form a powder containing approximately 20% PMA. This is used as a biocidal ingredient in wall board sealing compounds. The blending is done in a Patterson-Kelly V blender which has a disc type distributor and

an intensifier bar which prevents the formation of clumps. Each ingredient is added to the blender by a closed system. The calcium silicate is drawn into the blender by a vacuum system. PMA is added to the blender from a head tank located above.

IV. MERCURY CONTROL STRATEGY

A. Engineering Controls

1. Mercury Vacuum Pump Filter

A Calgon Vent-sorb filter is used to remove mercury vapor from the discharge of the vacuum pump in the elemental mercury transfer system. It consists of activated charcoal filter media housed in a 55 gallon drum. Pump exhaust air enters the drum at the bottom and is exhausted from the top of the drum to the roof. The filter is inspected monthly using a Bacharach MV-2 at the discharge to insure that breakthrough has not occurred.

2. Mercuric Oxide Charger Hood

When mercuric oxide is used to produce PMA, it is added to the reactor through an opening at which a specially designed removable exhaust hood is situated (Figure 3). The hood is used in the following manner:

- the reactor manhole is opened, vacuum is applied to the reactor, and the hood is put in place over the opening.
- A flexible exhaust duct is connected to an opening on the top of the hood (Figure 4).
- a plastic refuse bag is connected to an opening on the side of the hood (Figure 5).
- the worker opens the plastic liner of the 50 pound mercuric oxide container and empties the bag into the manhole.
- the empty bag is put into the refuse bag on the side of the hood. The refuse bag is sealed and disposed of in a drum for hazardous waste.
- the exhaust duct is disconnected, the hood is removed from the opening, the reactor is vented, and the manhole is closed.

1. All 304 stainless steel/fiberglass
2. Shelf must support repeated loading with 50 lb. weight (8 3/8" dia. X 7 1/4" high container)
3. 1 1/2" ring around ellipse is to secure unit to reactor manhole using manhole dogs.

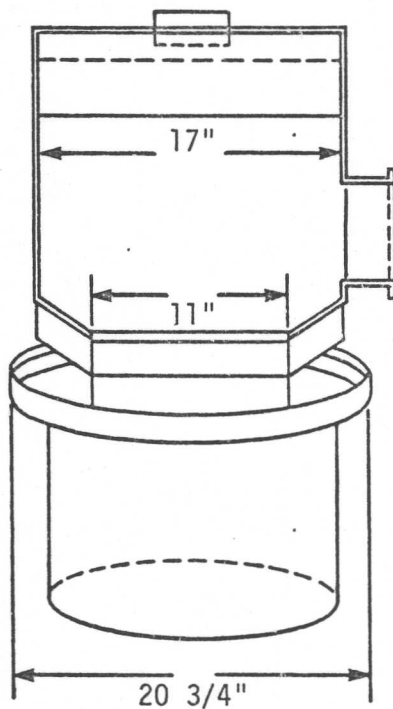
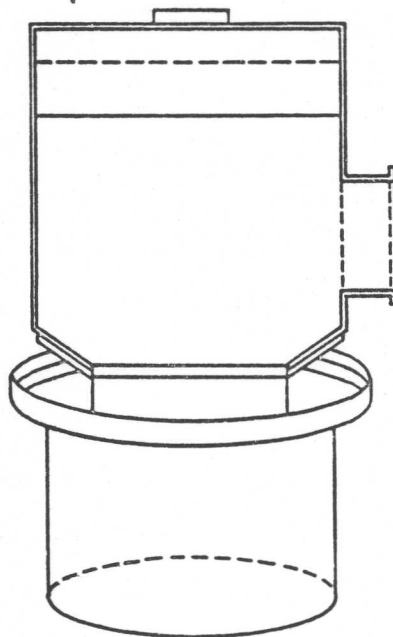
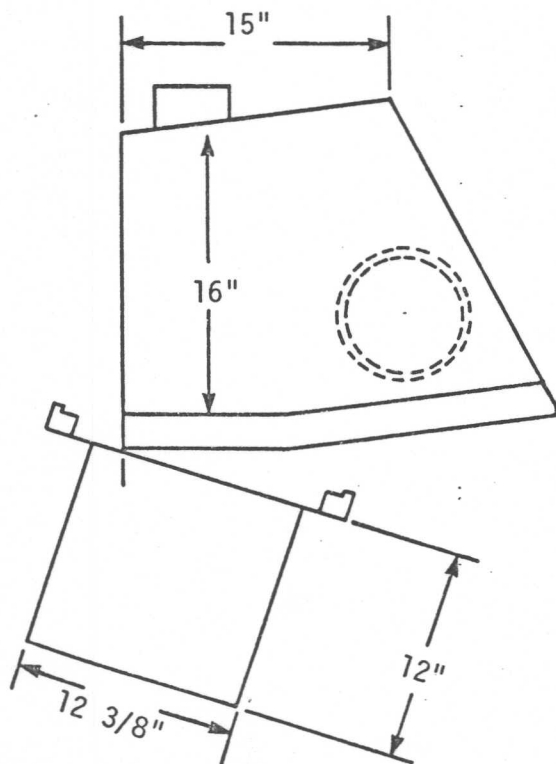


Figure 3. Mercuric Oxide Charger Hood Design
Reference: Cosan Chemical Corporation Drawing

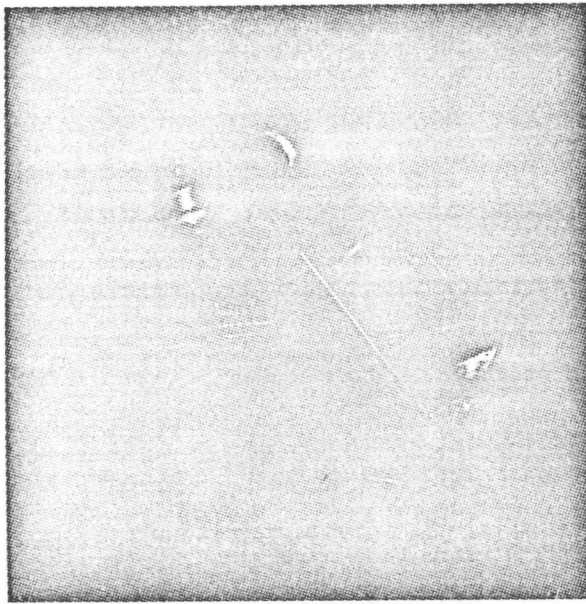


Figure 4. Exhaust Hood Showing Duct Connection

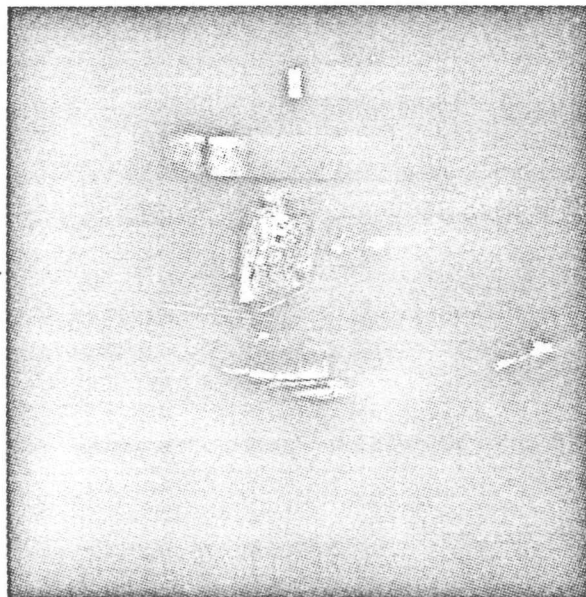


Figure 5. Exhaust Hood Showing Side Disposal Port

The exhaust hood is removable so that it can be used at any reactor being charged with mercuric oxide. The exhaust duct leads to a roof exhaust fan which draws approximately 430 cubic feet per minute (measured). A HEPA filter is used to remove the particulate mercury from the exhaust air stream.

3. Seals and Gaskets

Teflon gaskets are used at flange connections. Single or double mechanical pump seals are used depending on the application. Double mechanical seals are used for hazardous process flows where it would be permissible for seal water to leak into the process streams.

4. Baghouse Powder Fill System

Powdered PMA is packaged in plastic lined drums underneath the rotary valve and delivery chute on the baghouse. The plastic liner is connected to the chute so that the powder will not disperse into the air while a drum is being filled.

5. Spray Dryer Scrubber

A Heil Model 722 venturi scrubber is used to remove acetic acid from the baghouse exhaust air stream. It is a caustic recirculation unit designed to maintain pH above 12. The scrubber acts as a secondary mercury control because it reduces PMA emission to the atmosphere in the event of a bag breakthrough. The scrubbing solution is checked on an hourly basis to insure that PMA powder has not leaked through the baghouse. Air flow through the scrubber is vented to the roof.

6. Room Exhaust Fans

Table 1 shows the exhaust fans in the PMA production area.

Table 1

| <u>Location</u> | <u>Manufacturer</u> | <u>Size(Model)</u> | <u>Capacity (CFM)</u> | <u>Description</u> |
|-----------------------|---------------------|--------------------|-----------------------|----------------------|
| liquid PMA room | Twin City | 182 | 4890 | roof & floor exhaust |
| liquid PMA room | Twin City | 122 | 1390 | roof & floor exhaust |
| powdered PMA room | Twin City | 165 | 3390 | roof & floor exhaust |
| mercuric acetate room | Buffalo | 400BL | 6000 | roof exhaust |
| blending room | Chelsea | PLF30MA | 10000 | wall exhaust |

7. Drum Loading Exhaust Hood

Dilute PMA powder produced in the V-Blender is loaded in drums under a specially designed exhaust ventilation unit (Figure 6 and 7). The unit consists of a plastic dust hood (Figure 8) which is hydraulically lowered over the empty drum for filling. Three flexible exhaust air ducts are attached to the hood. Before loading the drum, a flexible chute is connected from the hood to the blender discharge. This helps to enclose the fill system and reduces powder dispersion.

The exhaust air ducts lead to a 16 bag Mikro Pul 16S-8-30 baghouse which uses a pneumatically controlled knocker to move filtered particles into a waste drum. Waste is recycled through the blending process.

8. Filter Press Exhaust Hood

A 2½ feet by 5 feet exhaust hood (Figure 9), balanced by a counter weight is lowered over the filter press when liquid PMA is being filtered. The hood has a large baffle inside of it so that a ½-inch slot is maintained around the periphery of the hood to increase exhaust air velocity.

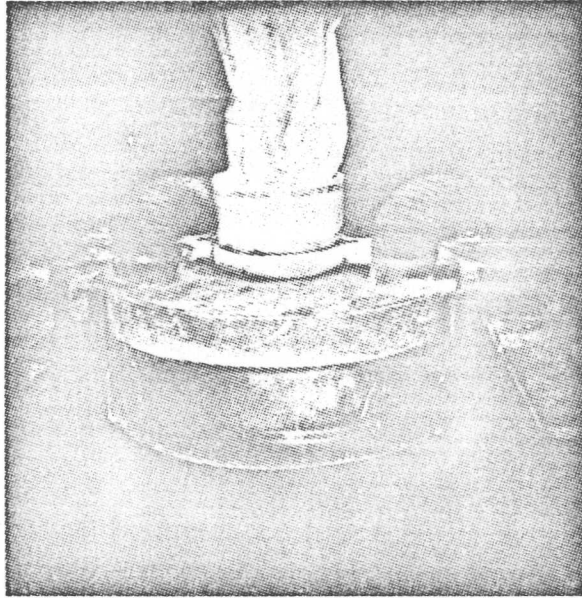


Figure 6. Drum Loading Dust Hood
Showing Exhaust Air Ducts

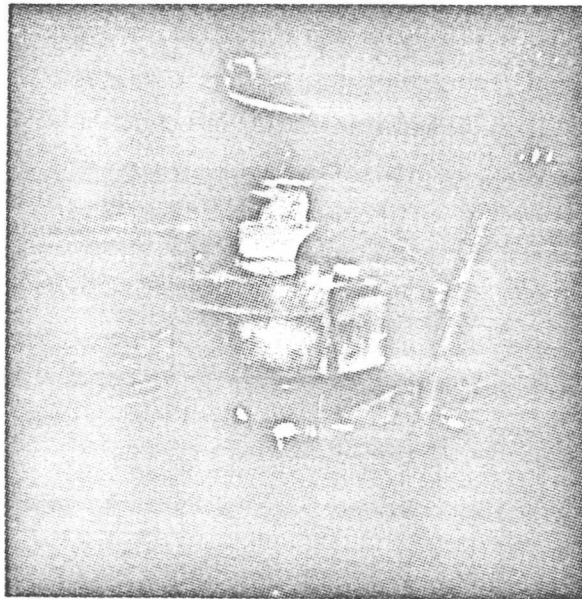
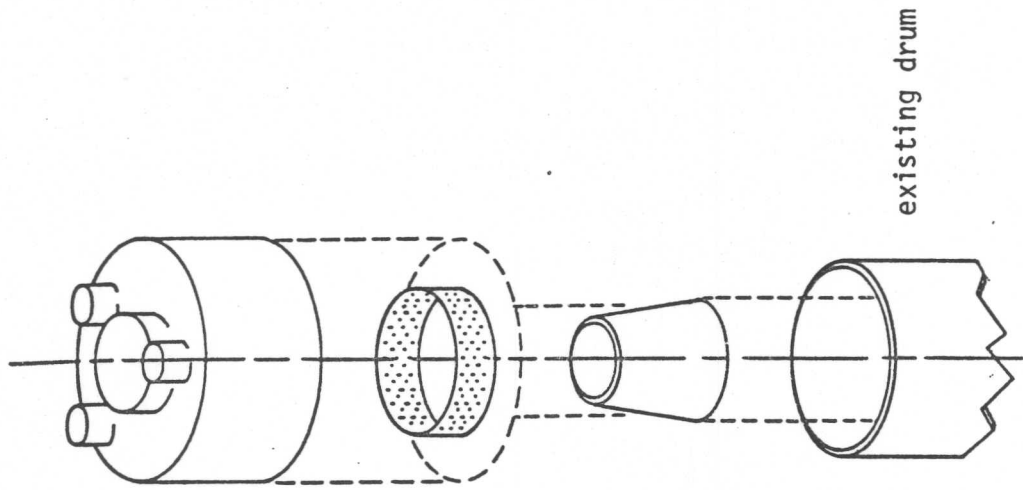
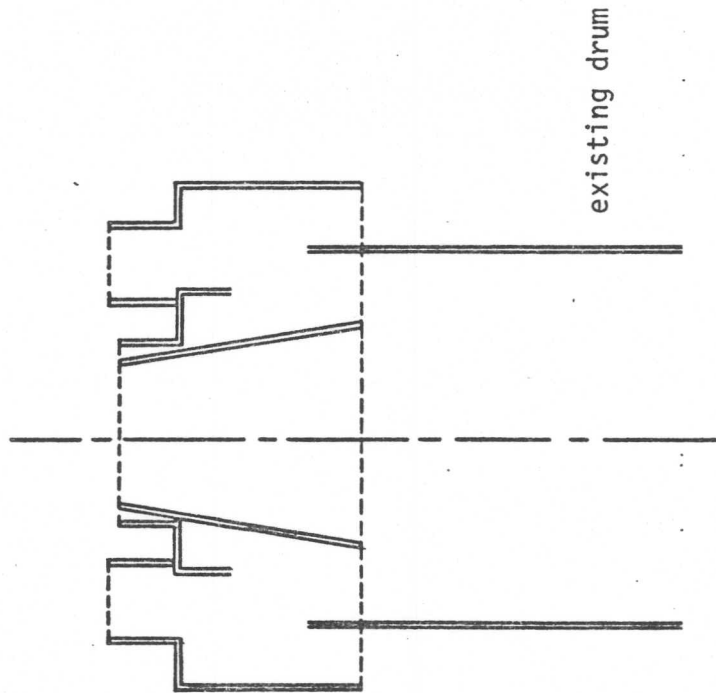


Figure 7. Drum Loading Dust Hood
Covering Chemical Drum



existing drum

Dust Collector
(Exploded View)



existing drum

Shroud
(Section View)

Figure 8. Schematic Drawing of Drum Loading Dust Hood New Line
Reference: Cosan Chemical Corporation Drawing # G-1-109

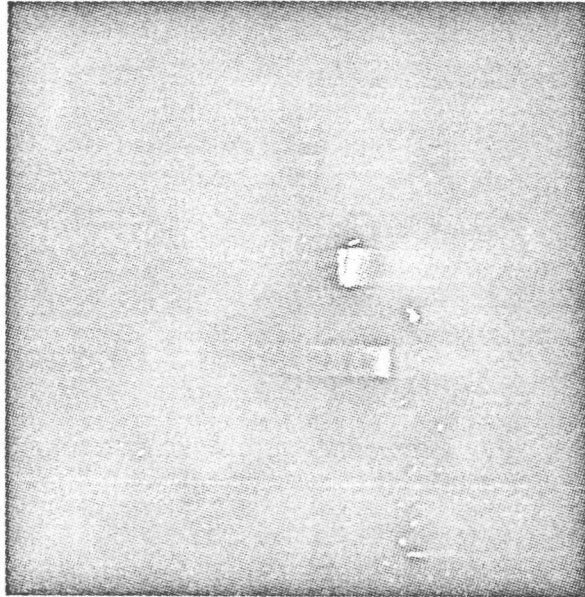


Figure 9. Filter Press Exhaust Hood

A twelve inch exhaust duct connects the hood to the same exhaust fan used for the mercuric oxide charger hood. The two controls can be isolated so that approximately 430 CFM can be drawn at either hood.

B. Personal Protective Equipment

Personal protective equipment used at this facility consists of the following:

- Respirators (MSA Comfo II[®]) are worn during certain operations where there is a high potential for exposure to mercury (either mercury vapor or particulate). These operations include PMA blending and cleaning filter presses. The respirators are equipped with a chemical cartridge designed to protect against mercury vapor (Mine Safety Appliances, MSA-Mersorb Indicator Cartridge #466204, not currently approved by NIOSH); and MSA type F dust filter approved for respiratory protection against dusts and mists (NIOSH approval No. TC-21C-133)
- Supplied air respirators are worn when cleaning baghouses
- Cloth uniforms and jackets are provided by the company. These are changed daily. Laundry service is provided by an outside company
- Gloves (latex/nitrile) are used when handling mercury compounds. These are changed daily or more often if visibly contaminated
- Disposable Tyvek[®] coveralls are worn when exposure potential is considered to be high (eg. cleaning baghouse)
- Work shoes are provided by the plant. They may not be worn home by the worker

C. Work Practices (other than housekeeping)

- Workers are required to shower at the end of the work day. Time is provided by the company for this activity
- Consumption of food or beverages is not permitted in work areas
- Job rotation is practiced within job grades

- Smoking is not permitted in production areas
- Workers are required to wash their hands before breaks

D. Housekeeping

In 1979 Cosan initiated a housekeeping program which included the following:

- Weekly cleaning of floors with ZEP[®] Super Flash (non-caustic alkali industrial cleaner)
- Monthly cleaning of all equipment and work stations with ZEP[®] Super Flash
- Daily floor cleaning using hose and water
- Immediate spill clean-up using 3M Adsorbent Pads (for aqueous and non aqueous materials)
- Contracting with an outside firm for removal of mercury containing waste

Prior to 1979 most of the above practices were in use at this facility (with the exception of the use of the ZEP[®] product). However, the housekeeping program was not strictly enforced. Plant representatives feel that the enforcement of the housekeeping program in 1979 resulted in a reduction in employee exposure to mercury based on results of biological monitoring.

E. Monitoring Programs

1. Biological monitoring

Biological monitoring is part of the company's medical program. Monitoring consists of both blood and urine analysis to determine levels of mercury. Biological monitoring is conducted twice per year. Spot samples (as compared to 24-hour composite samples) are collected for urine analysis. Blood samples are collected on the same day. The blood sampling program is administered by the Institute of Preventive Medicine. The comprehensive biological monitoring program was initiated in 1973 and involves the monitoring of all production workers. A less stringent program has been in effect since the inception of the company in 1965.

The current acceptable level at the facility for mercury in blood is 10 $\mu\text{g}/100\text{ ml}$. If a blood-mercury level is above the acceptable level the worker is relocated to an area or building where mercury is not used. The worker is reinstated when, after re-testing, the level is below 10 $\mu\text{g}/100\text{ ml}$ of blood. Although both blood and urine monitoring is routinely conducted, the consulting physician considers blood levels of mercury to be a more reliable indicator of exposure. Consequently, worker relocation at this facility is based solely on blood-mercury levels.

2. Air Contaminant Monitoring

Monthly monitoring is conducted to determine the levels of mercury vapor associated with various operations. This involves use of a direct reading mercury vapor detector (Bacharach MV-2). In addition, occasional sampling for airborne levels of PMA is conducted. The collection device for PMA consists of an impinger with potassium permanganate as the absorbing solution.

F. Other Programs

1. Medical

The medical program at this facility includes pre-employment and annual physical examinations for production workers. Biological monitoring samples are also collected during the examinations. The medical program at the facility is directed by a consulting Occupational Health Physician.

V. SURVEY DATA

Air monitoring using a mercury vapor detector (Jerome Model No. 401) was conducted during the survey. The results of monitoring are shown in Table 2. Area samples were taken, consequently, personal exposure may not be reflected in the sampling results. In addition, the sample concentrations reflect mercury vapor levels only. Levels of particulate forms of mercury (e.g. PMA or mercuric oxide) were not measured.

TABLE 1

MERCURY VAPOR LEVELS DETERMINED WITH
JEROME MODEL 401 MERCURY VAPOR DETECTOR
(7/16/81)

| <u>LOCATION</u> | <u>CONCENTRATION</u> mg/m^3 |
|-------------------------------|--------------------------------------|
| Outside (ambient air) | 0.004 |
| Hg Acetate Area | 0.050 |
| Hg Acetate Area | 0.050 |
| Hg Acetate Area | 0.050 |
| Hg Acetate Area (near floor) | 0.074 |
| Hg Acetate Area (near floor) | 0.065 |
| Blender Room (PMA Production) | 0.025 |
| Blender Room (PMA Production) | 0.040 |
| Blender Room (PMA Production) | 0.045 |
| Liquid Room | 0.052 |
| Spray Dryer at Fill Station | 0.042 |

VI CONCLUSIONS AND RECOMMENDATIONS

Results of sampling conducted during the survey indicate that Cosan is currently maintaining the mercury vapor level below the Occupational Safety and Health Administration's standard of 0.1 mg/m^3 (as a time weighted average). Mercury vapor control is achieved due to the integrated mercury control program consisting of effective engineering controls and good work practices. Sampling for particulate mercury is not routinely conducted at this facility. Sampling for particulate forms of mercury should be conducted on a regular basis to insure that hazardous levels are not present in the workplace.

Further study of four of the engineering controls used at the facility is recommended, these controls are:

1. Calgon mercury vapor filter - study effectiveness of mercury vapor adsorption.
2. Baffled hood over PMA filter press - determine the benefits of the baffle hood.
3. Mercuric Oxide loading hood - conduct air flow measurements and take mercury vapor/particulate readings during loading.
4. Dilute PMA powder drum loading hood - study system in greater depth and take mercury vapor/particulate readings.