MEMORANDUM

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TO: (See Attached Distribution List)

BY: Mr. J. F. Erdmann
Mr. M. E. Sutherland

DATE: December 27, 1960

SUBJECT: Impressions and Observations while Visiting Suspension Resins Plant of the Pantasote Company at Passaic, New Jersey

I. INTRODUCTION

It was the privilege of the authors to visit and observe the operation of the suspension resins plant of the Pantasote Company at Passaic, New Jersey, on October 15 and 16, 1960. The purpose of this visit was to assist and advise the Pantasote Personnel in regard to serious production and quality problems which had arisen in their plant starting late in September. These problems were blamed on impurities in UCC vinyl chloride monomer, the major portion of which was shipped from the South Charleston Plant. A previous visit concerning the same problem was made on October 5, 1960, by G. K. Graeber and M. E. Sutherland. Mr. P. G. Magnusson and Mr. J. K. Marshall of Chemicals Sales were present for both visits.

Pantasote was our largest customer for vinyl chloride monomer before the shipments were discontinued in November because of continuing operation and quality difficulties. This year we have shipped them more than 10 MM pounds, and in September alone, shipments amounted to 2.5 MM pounds. Potential sales to this customer are estimated to be 50 MM pounds per year within several more years.

II. FACILITIES

The suspension resins plant is a clean, attractive, compact plant designed and built by the Scientific Design Company. It is an adjunct to their calendering plant which has been in operation for a number of years. The first increment of production was installed and put into operation in 1956. This first unit consisted of only four autoclaves and was operated at about 11 MM pounds per year, but last year two more autoclaves were added to this unit which brought the capacity up to 15 MM pounds. In August, 1960, an expansion was completed which trebled the capacity of the modified original unit to a total annual capacity for PVC suspension resins of 45 MM pounds. This new unit, consisting of 12 autoclaves, was put into operation in September, and the old unit was shut down. There are three complete and independent polymerization and resin recovery lines, each having a capacity of 15 MM pounds per year of PVC resins, and two monomer de-inhibiting and recovery systems. Description of the facilities in detail follows and a block diagram of the plant is shown in the attached Figure 1:

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A. Monomer Storage

Monomer storage facilities consist of four underground tanks of which two are 40,000 gallons capacity and two are 26,000 gallons capacity. Tanks are provided with heating coils through which warm water is circulated to maintain the tanks at 80 psi pressure. No inert gas is used and only inhibited monomer as received from tank cars is stored in these underground tanks.

B. Inhibitor Removal System

Each system consists of a horizontal tank for engaging and separating the monomer and caustic solution, pumps for caustic solution and monomer, a spent caustic tank, a 30-plate rectifying column, a condenser, and a purified monomer storage tank of approximately 2,000 gallons capacity. The old monomer de-inhibiting and refining system serves only the original unit while the new system serves the expanded part of the plant.

C. Reaction System

The reaction system consists of eighteen - 2,200 gallon glass-lined Pfaudler autoclaves. As mentioned before, there are six in the old unit and twelve in the new unit. The piping on the autoclaves is very simple, with only four process lines connecting to a manifold on a 3-inch nozzle on each autoclave. The heat of polymerization is removed with river water flowing through a completely filled overflow jacket. The water is circulated through the autoclave jackets, to forced-draft cooling towers, and back to the autoclaves. A two-stage vacuum jet is provided for evacuating the autoclave during the charging procedure. The agitators are of Pfaudler design and are driven by a two-speed motor with a normal operating speed of about 120 rpm and another speed about 1/2 this value which is used during charging. Only one recording instrument, a combined temperature controller-pressure recorder, plus a pressure gauge are provided on each autoclave. A demineralizing unit provides process water for the autoclave charges.

D. Monomer Recovery

These facilities consist of a 100 gallon foam trap, a vacuum pump and two small centrifugal compressors, a small condenser, and a 100 gallon recovered monomer receiver. The vacuum pump and compressors are operated in series, with appropriate by-pass controls to correspond to the autoclave pressure reduction as charges are stripped after polymerization.

E. Resin Recovery, Drying and Packaging

These facilities include for each line, an autoclave transfer pump, two 10,000 gallon stainless agitated slurry tanks, a Sharples PY-3000, conical bowl centrifuge, a centrifuge feed pump, a Louisville warm air rotary dryer, a Mikro-Pulsaire collector (baghouse), a 3' x 3' Bar-Nun 40-mesh screen, and a St. Regis Fluo-Packer. There are no facilities for storing dried resin in bulk. They have storage space for approximately 3 MM pounds of resin in bags or Pillar-Paks.

III. PROCESS

Inhibited monomer is received in tank cars and unloaded to the underground storage tanks. Usually two or three cars are unloaded at a time. This procedure involves the use of a small compressor which pulls vapors off the storage tanks and compresses and discharges them on into the vapor space of the tank car to facilitate unloading. After a car is unloaded, the valving is changed so that the compressor pulls vapor from the tank car and discharges into the liquid filling line of the storage tank. The pressure on the tank car is thus reduced to about 5 psig. As mentioned before, these tanks are maintained at an 80 psi pressure - which corresponds to a temperature of 112°F - by circulating warm water through coils in the tanks.

Monomer is fed continuously from a storage tank through a small cooler by means of a pump located near the monomer de-inhibiting system several hundred feet away. The new monomer pump, recovered monomer pump, and a caustic pump discharge into a common line in which there are several mixing orifices. The mixture is discharged to a decanting tank where the caustic and vinyl chloride are separated. From this tank the caustic is re-circulated while the monomer is fed into the rectifying column at the 12th tray from the bottom. Caustic is replenished about once a week, and the spent material is hauled away in a special container for disposal.

The column is operated at 80 psig pressure, and feed is controlled by means of a hand operated globe valve and rotometer. The vapor from the column is condensed in a horizontal condenser. The purified monomer make is drawn off through an overflow loop on the overhead receiver, and reflux is manually controlled. The purified VCl from the overhead receiver, drops into the purified monomer storage tank. The feed rate to the column is manually controlled so as to maintain the level in the storage tank at the desired operating level. A flow diagram of the monomer de-inhibiting system is appended in Figure 2.

The autoclaves are charged in the following manner: After cleaning and inspection, warm demineralized water (50°C) is charged via a meter to the autoclave to the prescribed volume, and the catalyst, suspending agent, and other ingredients are added through the open manhole. The manhead is assembled, and a vacuum is pulled on the autoclave with a two-stage steam jet to an absolute pressure of approximately 3 psi. This is the equilibrium pressure at the temperature of the charging water. A close check is maintained to assure that air is not leaking into the autoclave during this step. It is required that the vacuum hold for 30 seconds with the suction line to the jets shut off. When tightness of the autoclave is assured, vinyl chloride is charged from the purified monomer tank through a meter into the autoclave. The charge is then brought up to the reaction temperature by circulating hot water (heated by means of live steam) through the jacket.

Once the charge is up to temperature and the reaction is started, the temperature controller takes over, regulating the cooling water flow through the jacket to maintain the temperature at the set point. The reaction is allowed to proceed until the desired conversion of 85 to 92 per cent is attained, which point is determined by the drop in pressure of the autoclave. The reaction requires about 15 hours.

When the desired conversion is reached, the reaction is terminated by stripping with two centrifugal compressors operated in series. When the pressure reaches near atmospheric on the autoclave the vacuum pump automatically kicks in ahead of and in series with the two compressors and pulls the pressure down to 3 psi absolute. Then the compressors and vacuum pump are shut down and the vacuum on the autoclave is broken with air. The stripped autoclave charge is transferred to one of the slurry tanks by means of a high capacity, low head pump. After the charge is transferred from the autoclave, the vessel is washed down with a water hose. It is necessary to manually clean the autoclaves by scraping only after about every third or fourth run. For runs in between cleaning, the hose washing serves to clean the walls sufficiently for the next run. A total cycle time of about 18 to 20 hours is obtained on the autoclaves.

The monomer vapors stripped from the autoclaves by the compressors and vacuum pump are compressed to about 80 to 85 psig and condensed in a small water cooled condenser. The liquid drops from the condenser into a small recovered monomer receiver and thence to a pump which discharges into the new monomer line feeding the de-inhibiting system. Thus, all recovered monomer is mixed with fresh monomer and receives caustic treatment and distillation before re-use. During normal operation recovered monomer consistently comprises about 10 per cent of all autoclave charges.

Five autoclave runs, blended together in one of the two agitated slurry tanks provided for each production line, comprise a blend consisting of about 28,000 pounds of contained resin. While a blend is being made in one tank, a completed blend in the other tank is being fed out to the recovery system. The slurry (about 35 per cent solids) is pumped from the slurry tank to the Sharples centrifuge. The de-watered resin, which is about 80 per cent dry, drops by gravity into the Louisville dryer. A stream of hot air within the dryer picks up the resin and carries it to the Mikro-Pulsaire baghouse where the resin and air are separated. The dried resin drops from the baghouse through a small 40 mesh screen into the Fluo-Packer by which the resin is packaged in valve-type bags.

IV. RESIN RECIPE OBSERVATIONS

Since the dry blending resin (Kohinor 652) was the particular material which Pantasote was having the most difficulty in producing at the time of our visit, we were permitted to observe their charges for several autoclaves. None of the amounts of materials was related to us, but our observations and knowledge of this type of operation permitted certain relationships and conclusions to be drawn as to the recipe used for this type of resin. This recipe is approximately as follows:

A.	Vinyl chloride/water ratio	40/60
B.	Vinyl chloride charged, lbs.	5,800
C.	H_2O charged, lbs.	8,700
D.	Suspending agent, polyvinyl alcohol (probably E88H), per cent of vinyl chloride	0.035 (approx. 2 lbs.)
E.	Catalyst, dilauroyl peroxide, per cent of vinyl chloride	0.185 (appros. 10.7 lbs.)
F.	Total charge volume @ 50°C, gals.	1,980
G.	Conversion, approximate	90%
H.	Resin produced per run, lbs.	5,250

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Several comments seem justified. The vinyl chloride/water ratio is a guess, but Mr. John Ertel, resin plant supervisor, spoke several times of producing about 5,250 pounds of resin per run. On other occasions he said their conversion was approximately 90 per cent - this was in turn confirmed by the approximate 10 per cent recycle of recovered vinyl chloride. Although we commonly call this size of Pfaudler autoclave a 2200-gallon vessel, the Pfaudler people refer to them as 2000-gallon vessels on the basis of operating them filled just to the level of the top man head gasket. This was the approximate lev l of operation noted for these charges, taking into account the deep vortex produced by the agitator. Thus, the figures for the total charge and ratio were derived.

The type and concentration of suspending agent was not directly disclosed. Others have reported seeing bags of duPont Elvanol in this plant on previous occasions. The amount of suspending agent was determined from a charge sheet and observation of an actual charging operation. In contrast to our practice of making an aqueous solution of the suspending agent prior to charging, th dry suspending agent was poured through the open manhead directly into the warm water in the autoclave just ahead of the granular dilauroyl peroxide. The use of dilauroyl peroxide as their catalyst was freely discussed.

As best we could determine, no other ingredients were used in this recipe, although notations of "glycerine added" were seen in several log sheets. The scattered timing of these additions suggests that glycerine may be used as the seal fluid for the mechanical seals and the additions were made to the seal fluid reservoirs on the autoclaves.

For reference, a sketch of one of the Pfaudler autoclaves is shown in Figure 3.

V. MANPOWER

A. Technical and Supervisory

The entire suspension resin plant operation is under the direction of John Ertel who reports to Ted Barks, the works manager of the combined operations of the calendering plant and the resin plant. Ertel has reporting to him two production engineers, one development engineer, three laboratory technicians, a clerk, and all of the hourly personnel.

Ertel and one of his production engineers, Ed Biehl, formerly worked in Firestone's vinyl resin plant at Pottstown, Pennsylvania. They came to Pantasote when the first unit was started up in ~~1953~~ 1956. Both of these men impressed us as being technically competent and efficient production men. No doubt much of the information which they acquired while working at Firestone was helpful in their development of the excellent line of resin which they now produce.

The development engineer, Charles Gionatti, who has been with Pantasote since August, was previously employed by Borden in their vinyl resins plant. We learned that his main project at the time we were there was the development of a vinyl chloride-vinyl acetate copolymer. We understand that they made their first production trial on this resin late in November.

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Harry Russell, vice-president of Pantasote in charge of all vinyl operations, reported that he had recently hired an expert on extrusion compounds who formerly worked for Western Electric Company. It was not clear just what functions this man would be responsible for, but the impression was given that he would work mainly in the marketing of the resin, performing technical service in the wire-coating and insulation industries.

The laboratory technicians gave the impression of being very competent in their testing of the resin although their testing equipment and laboratory facilities were very simple and limited. They could predict, for example, how the dry-blend resin would behave in the customers operation with a simple dry-blending test based on visual observations and time. No testing of the new monomer as received in the tank cars is done. Equipment is available for running only simple tests such as acid content of the monomer. A qualitative test is sometimes run for acetylene.

B. Hourly

There are a total of 35 people on the hourly payroll. Each of four shifts has seven operators, and there are four day operators and three day maintenance men. There are no relief men since each shift group works six straight shifts and then is off two days. Vacations are covered by men from the off-shift.

The shift operating assignments and general duties are as follows:

1. Lead Operator - Supervises entire plant operation on shift. Assists in operation wherever needed.
2. Monomer Purifying Operator - Unloads tank cars and operates ground level functions of the monomer de-inhibiting system.
3. Reaction Operator - Assembles, charges, reacts, and strips autoclaves. Removes autoclave manhead after charge is transferred. Controls feed flow to monomer de-inhibiting system; controls reflux flow to monomer refining still.
4. Utility Operator - Transfers charges to slurry tanks. Washes or cleans autoclaves after transfers. Operates water demineralizing system.
5. Recovery Operators (Two - one for each line) - Switches slurry feed tanks. Operates centrifuge, rotary dryer, baghouse, and screen. Packages resin in bags or "Pillar-Paks".
6. Fork Truck Operator - Helps recovery operators stack bags of resin into pallets and transports to storage area.

F r time worked in excess of 40 hours in one week and 8 hours in one day a 50 per cent premium is paid. Double-time is paid for Sundays worked, and we believe this same rate is paid for holidays worked. Each operator gets paid, on the average, an equivalent of 51-1/2 straight time hours for each 40-hour week.

The lead operators receive the top hourly pay rate of $2.54 per hour. The pay rates of the other six operators vary from about 15 cents per hour below this top rate down to a minimum of $1.84 per hour according to the job classification. The pay rate for the three maintenance men is probably equivalent to or slightly under that of a lead operator.

Despite the fact that this is a union plant the operators perform a variety of duties such as cleaning autoclaves; assembling and dismantling autoclaves; painting equipment, lines, and the work area; changing valves and lines; replacing steady bearings on autoclaves; packaging, storing, and loading resin; and sweeping floors and whatever else is necessary to maintain an excellent state of housekeeping. The three maintenance men do jobs which are beyond the scope of the operators such as repairing valves, repairing pump seals, replacing autoclave shaft seals, etc.

We asked Ertel how he was able to get the union to agree to having operators perform such a variety of functions in view of organized labor's historical and notorious attitude against the efficient use of manpower in such a manner. He said that before the plant was started up, he and others in Pantasote management had an understanding with the union that management would be allowed this fre dom of manpower utilization. They laid their cards on the table stating that they were a small company and unless they were granted such freedom they could not hope to have a profitable operation and, therefore, would not even venture into the resin business. The union agreed to Pantasote's request and, according to Ertel, relations between the union and management have been excellent thus far. According to Ertel and Biehl, the operators are extremely conscientious, quality conscious, and have the company's interest at heart. Ertel believes, however, that is is only a matter of time until the union will be asking for concessions because of outside pressures of other unions. He claims the reason for their success in building up such a good relationship with the hourly men is that none of them had previously worked in a chemical plant and, therefore, had no preconceived notions concerning duties restricted to craft lines and the like. These men thought that the way supervisors told them to do a job was the best way, if not the only way, to do it. This attitude is likely to chang .

As mentioned earlier, the old 15 MM lbs./yr. unit is now shut down and only the new 30 MM lbs./yr. expansion is being operated. When sales require it, the old plant will be reactivated requiring the addition of 16 hourly men. No additional salaried employees should be necessary.

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VI. PRODUCTS

Pantasote produces four types of PVC resins which are marketed under the trade name Kohinor. A brief description of each is as follows:

Kohinor 652 - This is their dry-blend resin and, according to evaluations of our own Development Department, is by far the best dry-blend resin on the market. Prior to thier expansion the demand for this resin exceeded th ir production capacity. In order to protect their market position, they produced all the dry-blend resin they could for sale and purchased calendering resin for their compounding plant. This resin has a specific viscosity of approximately 0.220 and is produced with a polyvinyl alcohol recipe.

Kohinor 650 - This is a special calendering resin having a specific viscosity somewhat lower than that of 652. We know nothing of the recipe for this resin.

Kohinor 648 - This is their main calendering resin and next to 652 in importance. Since the plant expansion went on stream, sufficient quantity of this resin has been produced to supply the compounding plant adequately as well as to provide some excess for sale. This is a medium viscosity resin probably similar to our QYSM-5 (0.170 specific viscosity). We believe it is produced with a methyl cellulose recipe.

Kohinor 635 - This is a low viscosity resin used for rigid sheeting. It is probably similar to our QYSA-5 (0.115) or QYSJ-5 (0.145) in specific viscosity. This resin is probably produced with a methyl cellulose recipe along with trichlorethylene molecular weight degrader.

As mentioned earlier, they are working on the development of a vinyl chloride-vinyl acetate copolymer, presumably for the flooring and record molding market, and successfully accomplished an initial production trial just recently.

VII. OTHER COMMENTS

A. The Pantasote suspension resins plant is very well designed. It lends itself to good housekeeping and efficient use of manpower and raw materials. There are no evidences of over-design or under-design of piping or equipment. The piping is very simple and is painted according to a color code for purposes of identification. Piping on the autoclaves is exceptionally simple and uncluttered, yet adequate. Instrumentation is simple and used sparingly. Control of flows in most cases is efficiently and effectively accomplished by use of indicating rotometers and manually operated globe valves rather than by automatic controllers and motor valves. Measurement of water and monomer which go into the autoclave charges is satisfactorily accomplished by means of displacement meters.

B. In the plant there is wide-spread use of aluminum insulation sections on lines and equipment. This type of insulation is extremely easy to assemble or remove, makes a very neat job, and is undoubtedly much cheaper than the type of insulation used in our plants. If

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maintenance needs to be done on an insulated tank or line which involves removal of insulation, the aluminum insulation sections may be easily removed and then reinstalled after the maintenance work is completed. In our plant the foam glass or magnesia insulation is a one-time job and if removed is not salvagable. It seems that our design and maintenance engineers should investigate and adopt the use of cheaper and more modern insulation methods and materials such as this. Much money could be saved.

C. We were impressed with the high productivity of the 2,200-gallon autoclaves. With the 33 per cent larger ratio of wall cooling surface area to charge volume in these small autoclaves as compared with our 4,600-gallon autoclaves, they may use water at atmospheric temperatures to effectively remove the heat of reaction, whereas we must use -20°C brine for equivalent productivity. Another more important advantage of the small autoclaves may be that this is the secret of their producing an excellent dry-blending resin. It is possible that the critical agitation required for this resin cannot be scaled up to a larger vessel.

D. According to Ed Biehl, the monomer efficiency under normal circumstances is around 95 per cent, and the overall final resin cost (including all overhead and selling expenses) exclusive of freight is about $0.16 per pound. This is with a monomer purchase price of $0.116 per pound delivered. Since this conversation the monomer price has been reduced to $0.096 per pound and the overall resin cost should be lower by about $0.021 per pound. A good portion of the resin shipped to customers is picked up by customer's own trucks so that freight expense is extremely low. Biehl stated that on the average they pay about $0.25 per 100 pounds or 1/4 cent per pound for freight. This would bring the overall (monomer price-freight adjusted) resin cost to about $0.142 per pound.

E. The Louisville rotary drying systems impressed us as being vastly superior to our flash drying systems from the standpoint of resin contamination, resin losses, and ease and smoothness of operation. Becaus of the absence of conditions conducive to overheating and fusing of the resin, such as exist in a flash drying system, this dryer is particularly well suited for drying of the soft resins such as the suspension resins, VYSR and QYSA-5, and the solvent resins VYLF, VYHH, and VMCH.

F. All of their pumps and agitators are equipped with mechanical shaft seals supplied by John Crane Co. They had a considerable amount of trouble with failures of the original seals on most of their pumps, and all have been replaced with the John Crane seals which are reported to give service in excess of a year. They have obtained excellent cooperation and customer service from this supplier and are very well pleased with the improved seals which, according to Ed Biehl, were developed through the joint efforts of Pantasote and Crane.

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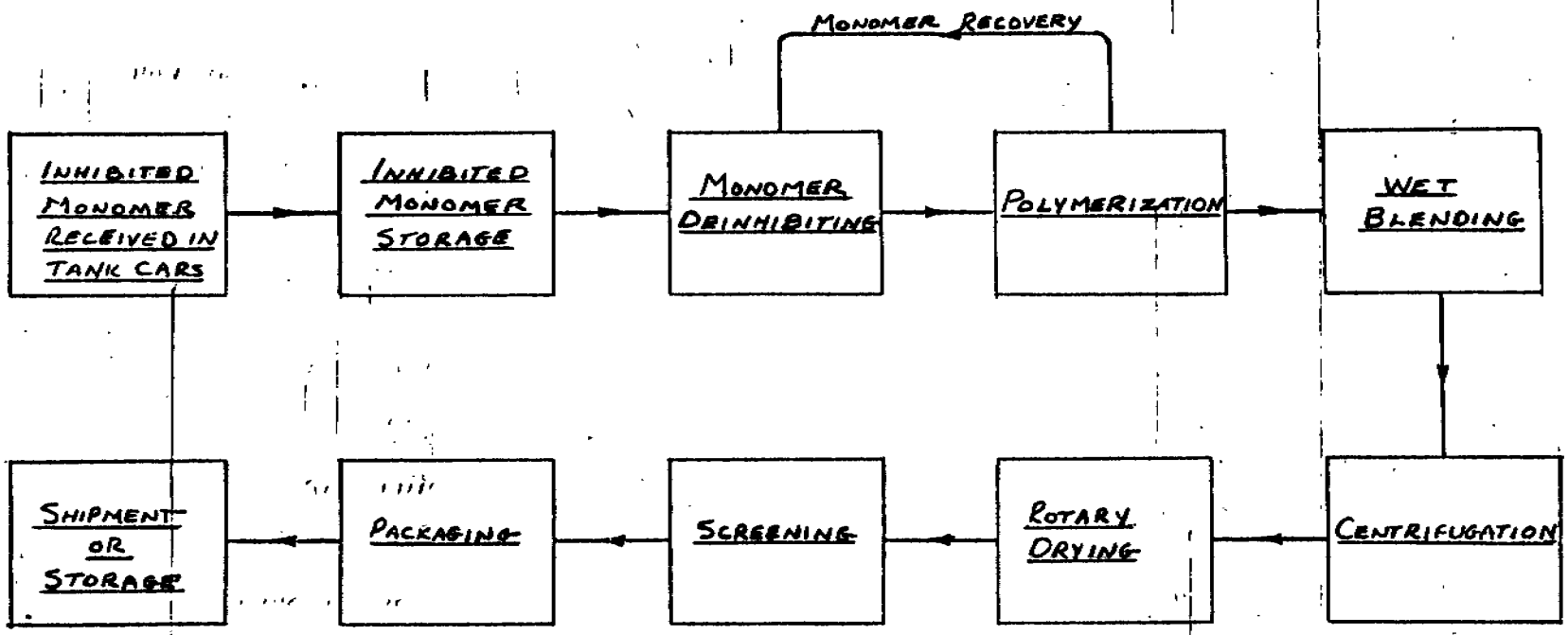

FIGURE 1

BLOCK FLOW DIAGRAM OF SUSPENSION RESIN PROCESS OF THE PANTASOTE COMPANY AT PASSAIC, NEW JERSEY

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FIGURE 2
FLOW SHEET OF MONOMER DEINHIBITING SYSTEM — SUSPENSION RESIN PLANT OF THE PANTASOTE COMPANY PASSAIC, N.J.

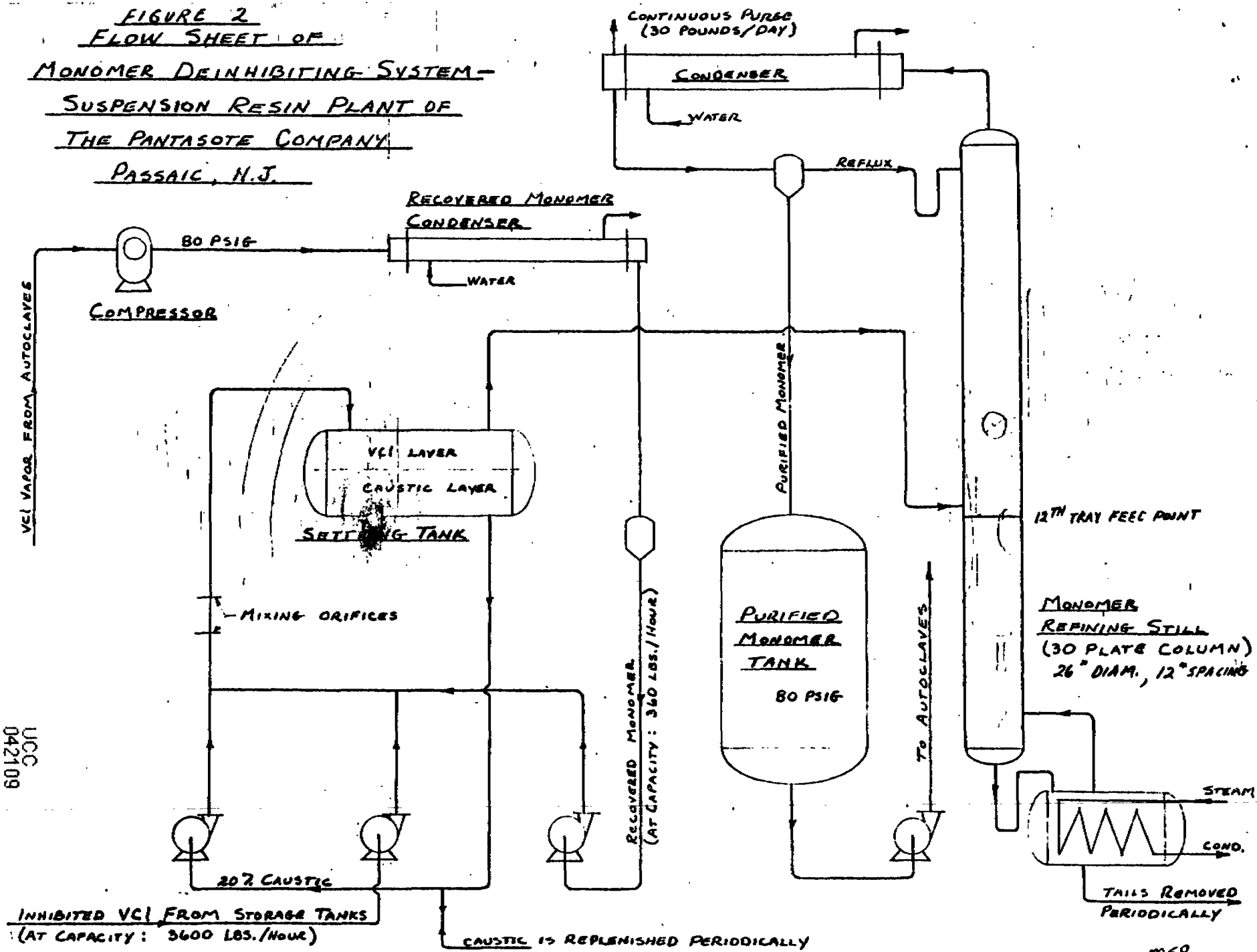

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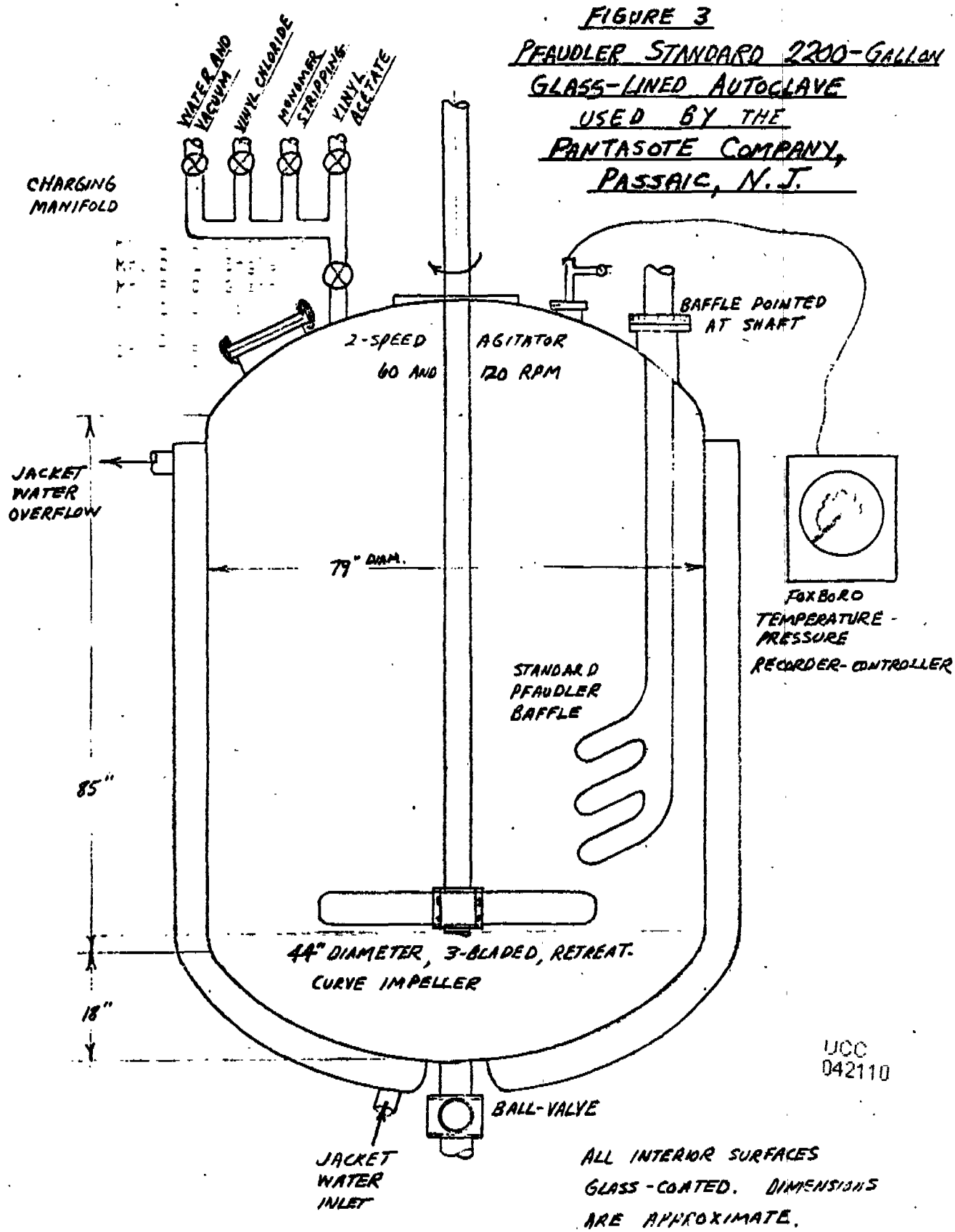
FIGURE 3

PFAUDLER STANDARD 2200-GALLON GLASS-LINED AUTOCLAVE USED BY THE PANTASOTE COMPANY, PASSAIC, N.J.



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ALL INTERIOR SURFACES GLASS-COATED. DIMENSIONS ARE APPROXIMATE. VESSEL PRESSURE RATING 200 PSIG

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TO: Mr. J. W. Biddle
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Mr. W. R. Wheeler

DATE: December 29, 1960

WWT/01/03/61

SUBJECT: Memorandum entitled: "Impressions and Observations while Visiting Suspension Resins Plant of the Pantasote Company at Passaic, New Jersey"

Gentlemen:

Please make the following correction in your copy of the subject memorandum:

Page 5, second paragraph under "Manpower" heading, second sentence should read: "They came to Pantasote when the first unit was started up in 1956".

Thank you,

M. E. Sutherland

M. E. Sutherland

J. F. Erdmann

J. F. Erdmann

MES/JFE/bcm

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