Polyvinyl Chloride Plant

LOUISIANA

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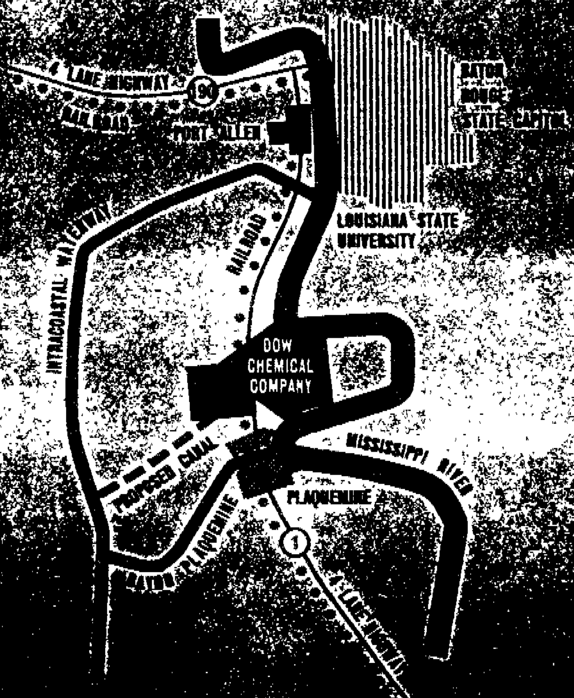

DOW THE DOW CHEMICAL COMPANY

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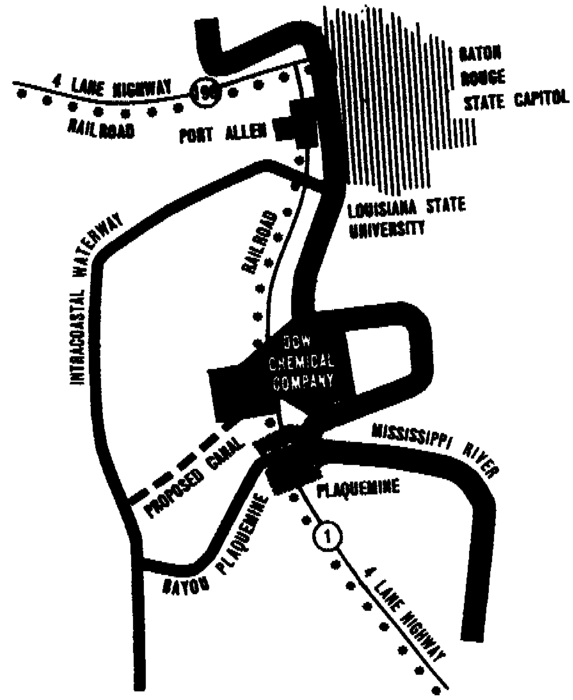


The Dow Chemical Company's Louisiana Division at Plaquemine, just south of Louisiana's capitol city of Baton Rouge, is located on a 2900-acre tract fronting on the Mississippi River and bisected by Louisiana Highway 1 -- a main state artery. There is immediate access to an excellent transportation network of railroads and pipelines.

The Louisiana Division of Dow, headed by James H. Means, has been operating for 10 years. It was the first chemical complex to locate on the west bank of the Mississippi River in the Baton Rouge area.

Dow's Louisiana Division's employees number more than 1,000. An additional 400 people work in contract maintenance and service jobs, and another 900 are currently employed on construction projects.

The division's first production plants went into operation in 1958. Additional plants came on stream every year from 1959 through 1963. At present the division consists of 11 production plants, power and steam generating facilities, a research and development department, and administrative services.

Dow Louisiana is in a position to offer technical assistance, advice and a variety of auxiliary services to potential neighbors.

Labor Policy

The Louisiana Division has no contracts with labor unions. All division employees are classified as salaried personnel which allows the division to operate with a single set of policies and practices for all employees. This program was established at the beginning of the division's operations in 1958 (Non-Dow labor information on page 19).

Within this framework, all salaries are administered on a merit basis. The type of operation has distinct advantages including company identification, rather than union identification, greater flexibility in work assignments, performance of maximum amount of maintenance work by operators, minimum jurisdictional problems, individual consideration, elimination of negotiations and strike threats or work stoppages.

The Louisiana Division has developed an industrial relations program of support and administration of its program, including indoctrination, training, salary administration, promotions, job structuring, employee development and communications, and will act in an advisory and counseling capacity in the establishing and administration of such a program in the PVC facility.

The labor supply and quality is good. The presence of Louisiana State University is a definite asset in that many people with one to four years of college education are available for operating technician positions.

BULK PVC PROCESS

The new PVC plant under construction at Dow's Louisiana Division is designed for the two-stage bulk polymerization process developed by Pechiney-Saint Gobain (P-SG) in France and is licensed to The Dow Chemical Company. In the U. S., Hooker Chemical Company and B. F. Goodrich are also licensees of this process which is relatively new in this country.

In the bulk process, monomer and catalyst are reacted to approximately 10 per cent conversion in a vertical, turbine-agitated reactor called a prepolymerizer or PREPO. After 10 per cent conversion, the charge from the PREPO is transferred into the second stage polymerizer, called a POPO, where additional monomer and catalyst are added and the polymerization is continued to 70-85 per cent conversion. The POPO is a horizontal, internally agitated autoclave especially designed to balance heat removal and agitation requirements of the bulk process to produce bulk PVC resin with excellent properties.

At the completion of the polymerization, the excess monomer is recovered for re-use in the process. The dry resin (this process has no water medium) is transferred to a finishing building where the resin is screened for packaging and/or storage.

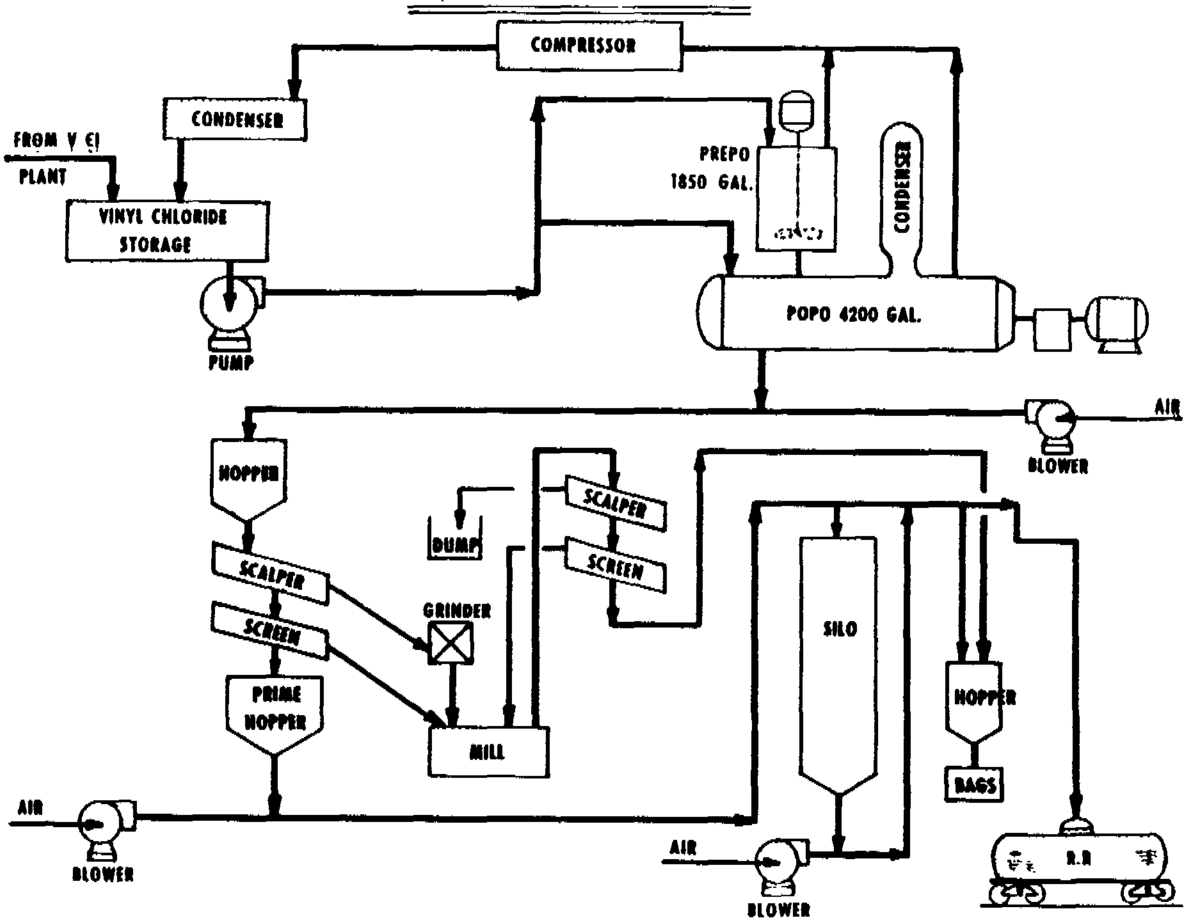
A lower capital investment is realized for this process because there is no need for dewatering or drying since water is not used as the processing medium.

The absence of emulsifiers and colloids in the bulk process results in a unique structure of the polymer particles owing to a mechanism of chain association different from conventional suspension or emulsion processes.

PVC resins manufactured by the bulk process have excellent properties and fabrication attributes:

- Low gels
- Excellent plasticizer acceptance
- Excellent clarity
- Good bulk density
- Good heat and light stability
- Narrow particle size distribution

MASS PVC PLANT



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The present plant includes one polymerization train with one PREPO and four POPOs. The balance of the processing and finishing equipment is designed to handle product from two polymerization trains. The plant site was planned long term to accommodate four trains of polymerization and finishing structure.

Based on initial P-SG data, one train is capable of 30$\overline{M}$ pounds/year gross production of bulk PVC at k value = 65. Potential improvements in the process suggest it is possible to substantially increase this capacity.

Vinyl chloride monomer is produced in the Louisiana Division and is piped to the PVC plant.

RIGID PVC COMPOUNDS
Mass Resin

The inherent features of PVC resin prepared via the mass polymerization route have enabled the base of the PVC compound area to be broadened.

Dow has taken full advantage of the inherent cleanliness of the resin to develop very high clarity blow molding, injection molding, and sheet and profile extrusion compounds. Compounds are available in each area for both FDA and non-FDA applications and all have been extremely well received in the field.

The higher bulk density and more uniform particle size of the mass PVC resin have enabled Dow to produce dry blend PVC pipe compounds having higher output rates than conventional materials.

Three such compounds have been approved by the Plastics Pipe Institute and National Sanitation Foundation for potable water and are listed as PVC 1120. In addition, several drain, waste and vent compounds are available.

Two-Step Bulk Polymerization of Vinyl Chloride

J. C. Thomas, Pechiney-Saint-Gobain, Saint-Fons, France

In addition to polymerization cost economies, the process offers exceptional material properties

Bulk polymerization is the oldest and the simplest process for the polymerization of monomer substances. Its importance is not limited to the preparation and study of high polymers in the laboratory but also applies to industrial mass polymerization processes. Some of these advantages are:

- The use of simple equipment and lower amount of investment as there is neither water nor solvent to be separated.
- Rapid reactions and a good yield.
- Polymers have high purity, with good heat stability and excellent transparency.
- A particular structure of the polymer beads, since the mechanism of association between the chains of the high polymers is different in the absence of any emulsifier or protective colloid.

On the other hand, bulk polymerization generally involves two difficulties:

- One concerns the agitation of the medium. This is especially true when the polymer is soluble in the monomer since the viscosity increases considerably as the reaction proceeds.
- The other concerns the elimination of the heat given off in the course of the polymerization reaction. For the polymerization, of the polyaddition type, the propagation of the chains which results from the transformation of a double bond into two simple bonds is a very exothermic reaction. Heat transmission by conduction and convection is difficult when the viscosity of the medium is high, or when there is present a polymer insoluble in its monomer. The heat transfer coefficient between a powdered solid and the wall of a reactor is poor.

To overcome these two difficulties, the process of polymerization in suspension was developed even though it presented other major inconveniences. The dispersions of solid granules in water are easy to agitate, and the water serves as a thermic buffer permitting significant increase in the total heat transfer coefficeint.

Why Bulk Polymerize Vinyl Chloride?

Vinyl chloride is a liquid which boils at −14°C and has a very low viscosity (0.2 cp at −14°, 0.193 cp at 25°C). The polymer is insoluble in the monomer and precipitates to form beads which even under a slight agitation do not have a tendency to agglomerate. The medium can be agitated in a homogeneous way without difficulty. The tempera-

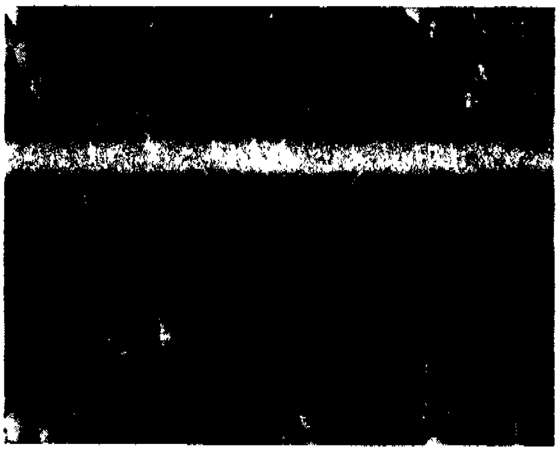


Figure 1. Mass PVC resin K-value 62 (x120).

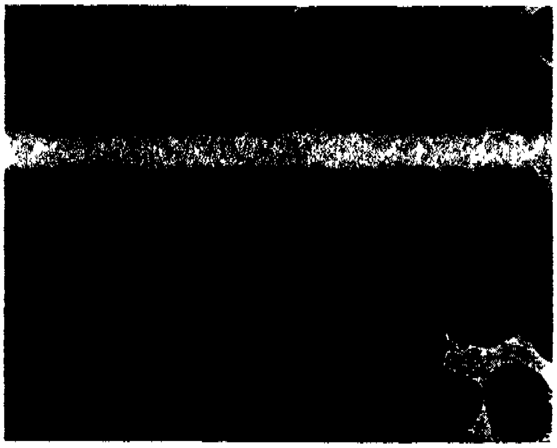


Figure 2. Mass PVC resin soaked with di-octyl phthalate (x150).

ture of polymerization is generally between 40° and 70°C, and the monomer in the reactor is under a pressure from 5 to 12 kg cm^2 (75-175 psi).

The liquid monomer is constantly in equilibrium with its vapor, and it is easy to remove the heat of reaction by distillation and recondensation of the monomer on the wall of the reactor. In the same way, the unreacted vinyl chloride monomer may be removed at the end of the reaction. This condition produces a particularly favorable situation when polymerizing vinyl chloride in bulk.

Microstructure of Mass PVC

The bead of "mass" PVC is characterized by a structure different from that of the suspension PVC bead due to the absence of the protective colloid. The bead of the "mass" PVC, 80-200 microns diam, is constituted by the direct and isotropic juxtaposition of granules having a diameter of 0.5 microns which are homogeneous in dimensions and in structure, *Figures 1, 2, 3 and 4.*

Whatever the condition of polymerization, the granules apparently keep constant dimensions. Their arrangement determines the morphologic characteristics of the polymer, *Figures 5 and 6.*

The association of the micronic granules, which is different according to the type of polymerization and of drying, determines the characteristics in the uses of the PVC resins. The study of the microstructure of these resins permits us to understand the exceptional properties of "mass" PVC.

In order to explain this microstructure it is necessary to examine what happens in the course of bulk polymerization of vinyl chloride and during the formation of the polymer beads. The reaction is a "free radicals" type polyaddition. The initiator generally being an organic peroxide soluble in the monomer.

The vinyl chloride inclosing the initiator in solution is rapidly brought to the temperature at which polymerization must take place. Even before the temperature level is reached, fine particles precipitate and create an opalescence. Then they progressively make the liquid opaque. This opaqueness is due to the polymer chains which are insoluble in the monomer and which remain at an individualized state so long as their concentration remains weak (less than 1% with respect to the monomer). There is no induction period for the polymerization.

As the polymerization continues, the concentration of elementary particles increases, and a phenomenon of polymer chains association can be ascertained which gives birth to the elementary granules. The elementary granule is the smallest particle visible in the PVC bead under the electron microscope. The average dimension of these granules at the time of their formation is about 0.1 micron.

The number of granules does not change during the polymerization reaction, but their average diameter increases to about 0.9 to 1 micron when the rate of conversion of monomer is close to 80%. A recent Russian study (1) confirms this research and shows by means of analysis of the number and size of the particles that the population of the granules remains constant in the course of the reaction. By analogy with crystallization, the probability of particle fixation on an already solid surface is greater than the probability of the formation of new beads. The growth of the granules is made by fixation of new polymer chains at their surface, either by formation of chains inside of the granules, or by initiation of chains at their surface by a transfer reaction with the polymer.

As polymerization continues, a second stage of association occurs, this time at the expense of granules which are juxtaposed in order to form the definite beads. This phenomenon is produced when the polymer concentration in the monomer attains 2 to 3%. A count of the beads has shown that, also at this level of association, there are no new beads formed in the following phases of the polymerization.

Polymerization continues with the disappearance of the free monomer on the outside of the beads (polymer concentration being about 20%). Then the medium progressively takes the appearance of a dry powder (polymer concentration being about 40%).

One-Step Bulk Polymerization

One-step polymerization is a reaction which is carried out entirely in the same reactor. On the other hand, a two-step polymerization is successively realized in two reactors of different types.

The one-step polymerization is the most generally used process for bulk polymerization. This technique has been used by all those who have tried to achieve

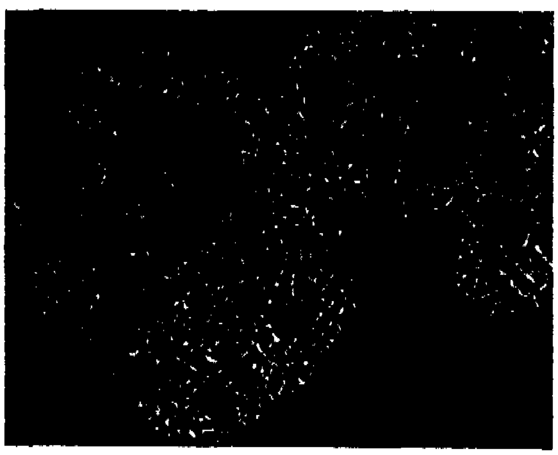


Figure 3. Microtome of a mass PVC bead expanded and embedded in polymethylmethacrylate (x300).

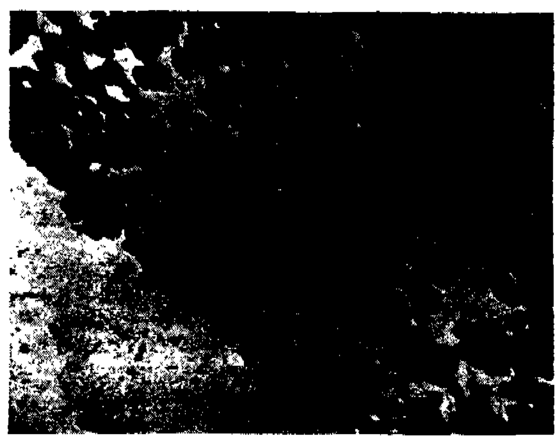


Figure 4. Electron microscopy of a mass PVC bead (x2500).

Figure 5. Electron microscopy of a suspension PVC bead (x5000).

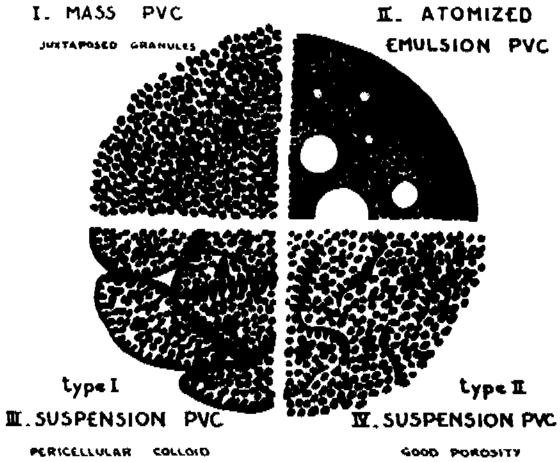


Figure 6. PVC bead—ave. diam 100 microns—constituted of micronic granules associated in different ways following polymerization and drying.

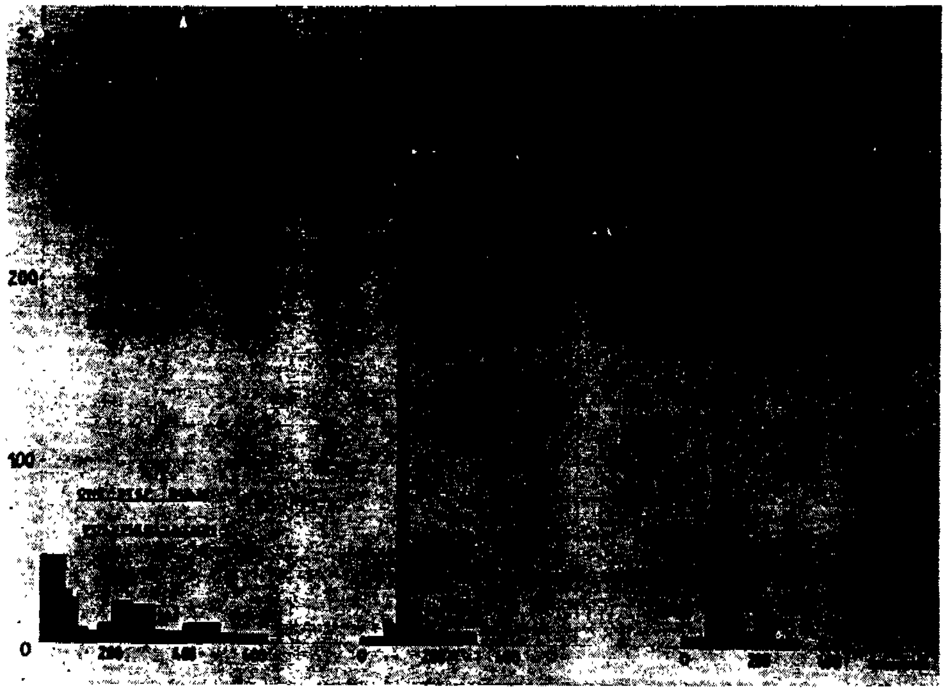


Figure 7. Particle size distribution.

the bulk polymerization of vinyl chloride, in laboratory as well as on the industrial scale. In all cases conventional apparatus has been used, and it is here that the essential cause of failure arises.

This type of reaction presents the following peculiarities:

- It begins in an homogeneous liquid medium of very low viscosity.
- It ends in an essentially solid phase, the vinyl chloride monomer being absorbed by the PVC beads.
- The volume occupied by the medium doubles from the beginning to the end of the polymerization.

The major difficulties revealed are:

- In case of a bad agitation of the solid phase, the eventuality of coagulation and afterward the possibility of an uncontrollable reaction.
- In case of a badly adapted agitation in the liquid phase the acquiring of a polymer of low apparent density and of large particle size distribution.

For several years a one-step polymerization process was successfully exploited by Pechiney-Saint Gobain. The resins produced answered the criterium of purity (heat stability and transparency) hoped for in mass resins. One of their important applications was in the field of artificial yarns, where they gave results superior to suspension resins and even more so to emulsion resins. Nevertheless the limitation in the use of these resins was due to their low apparent density and to their large particle size distribution that did not allow for their use in the new techniques of transformation directly from powder (*Figure 7*).

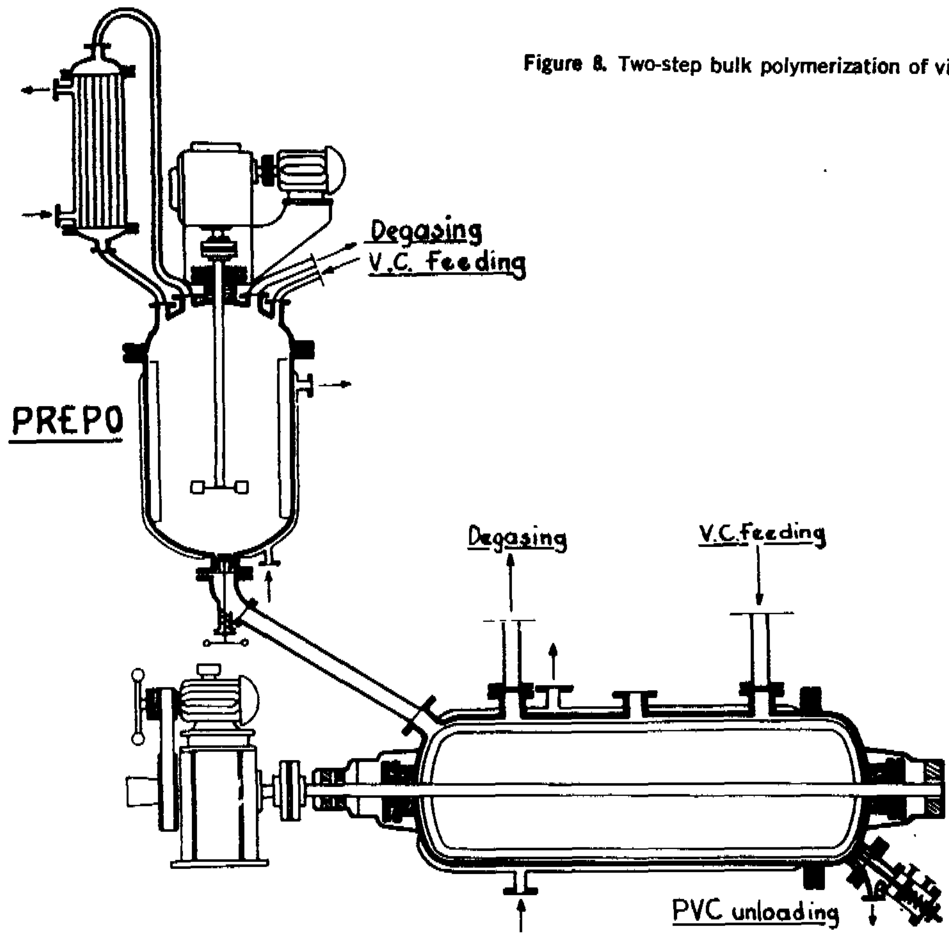


Figure 8. Two-step bulk polymerization of vinyl chloride.

Two-Step Bulk Polymerization of Vinyl Chloride

The principal objections to the bulk polymerization process of vinyl chloride are of two types:

- *Technological type*: There is a difficulty in realizing a reaction which begins in a liquid medium of 0.9 density in order to end in a powdery medium with an apparent density of 0.5.
- *Structural type*: The resins obtained have more often a larger particle size distribution and a low apparent density.

The reaction mechanism shows clearly that it is possible and desirable to realize the bulk polymerization of vinyl chloride in two steps.

The first step is carried out in an essentially liquid medium and is a bead formation phase. The step is short since the beads are formed as soon as 3% of vinyl chloride is polymerized; however, it is necessary that the cohesion of these beads be sufficient, and for this reason a rate of conversion of 7% is necessary.

The second step is a growing phase for the beads and can be accomplished in an apparatus suitable to the reactions in a powdery medium.

The initial phase, called prepolymerization, is realized in a stainless steel vertical autoclave (*Figure 8*). The conditions of agitation have a preponderant influence on the determination of the bead's structure, and we have found that a very turbulent agitation was indispensable in order to obtain spheric beads of high density. A good flow of the medium in the reaction is also necessary. It was necesssary to equip the "prepo" with a flat-blade turbine and baffles to avoid the formation of a vortex in this medium of very weak viscosity. The volume of the industrial reactors is about 8 cu m.

Experiments showed that it was not necessary to prepolymerize the total batch of vinyl chloride monomer. Prepolymerization of half the batch was sufficient to suitably seed the reaction and to obtain a resin of satisfying structure in the second reaction. This allows for the size of the "prepo" to be cut in half.

Control of the Bead's Structure

The essential phase of the reaction in the determination of the bead's structure is in the prepolymeriztion phase. According to the nature of the agitation, either regular spherical beads or beads without any geometrical form, whose particle size distribution is large, are obtained. The average dimension of the beads varies with the intensity of the turbulent agitation as shown in *Table 1*.

In modifying the intensity of the agitation, it is also possible to vary the arrangement of the elementary granules, hence the compacity of the beads, in order to obtain polymers of various apparent density. The usual range of variation is from 0.4 to 0.65.

This possibility of action on the bead's structure permits us to obtain resins adapted as well as possible to the end applications, without modifying other characteristics of the polymer as is the case in suspension polymerization when the nature of

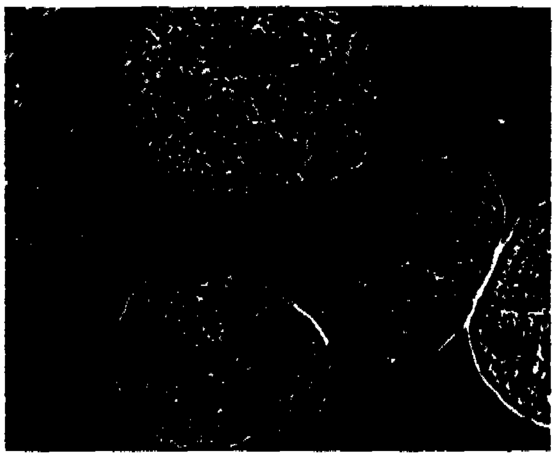


Figure 9. Microtome of a chloroacetate mass copolymer bead in polymethylmethacrylate (x300). An homopolymer bead is seen in the top center.

Table 1. Effect of agitator size and speed on bead size (microns).

Speed rpm	Turbine diameter 10 in. 254 mm	12 in. 305 mm	14 in. 356 mm
230	200	180	160
300	170	150	120
350	140	130	90

Note: One cubic meter autoclave. Agitator: flat blade (6) turbine

the protective colloid is changed.

- high density, coarse granulometry → rigid extrusion
- high density, fine granulometry → rigid calendering
- medium density, coarse granulometry → plastified extrusion
- medium density, medium granulometry → plastified calendering

In all cases, "mass" PVC resins are characterized by a good porosity of the beads due to their very structure, and they are consequently particularly suitable for the absorption of stabilizers, plastifiers and other ingredients necessary for their use.

Bulk Copolymerization of Vinyl Chloride

Only the homopolymerization of vinyl chloride has been treated; however, this technique is perfectly adaptable for the preparation of copolymers of vinyl chloride base which are insoluble in their monomers, *Figure* 9.

The copolymers present characteristics, excellent transparency and initial color, peculiar to polymers obtained by bulk polymerization. Moreover, the structure of the homopolymers is maintained throughout. Hence, it is possible to obtain copolymers with vinyl acetate having a suitable porosity.

As for all copolymerization, it is necessary to take into account the characteristics of the monomers used, in particular their rate of polymerization. The continuous introduction of the monomer whose polymerization is the fastest is a simple operation, since the bead during polymerization is not protected by any barrier.

The conditions of the reaction must obviously be adapted to the monomers present. In particular the speed of agitation in the prepolymerizer must be adjusted since the viscosity of the medium is often different from that of vinyl chloride.

It is necessary in copolymerization to maintain a constant temperature rather than a constant vapor pressure, since vapor pressure varies during the reaction with the change in monomer concentration.

Conclusion

The bulk polymerization process, which has long been of interest in the laboratory but not commercialized by most specialists on polymerization of vinyl chloride, is today the object of increasing interest.

Adapted from a paper given at SPE ANTEC, Detroit, May 1967.

Reference

Bort, D. N., Rylov, E. E., Okladnov, N. A., "Morphology of Mass PVC," *VYSOKOMOLEKULYARNYE SOEDINENIYA* 1965 n° 1 50/4

About the Author

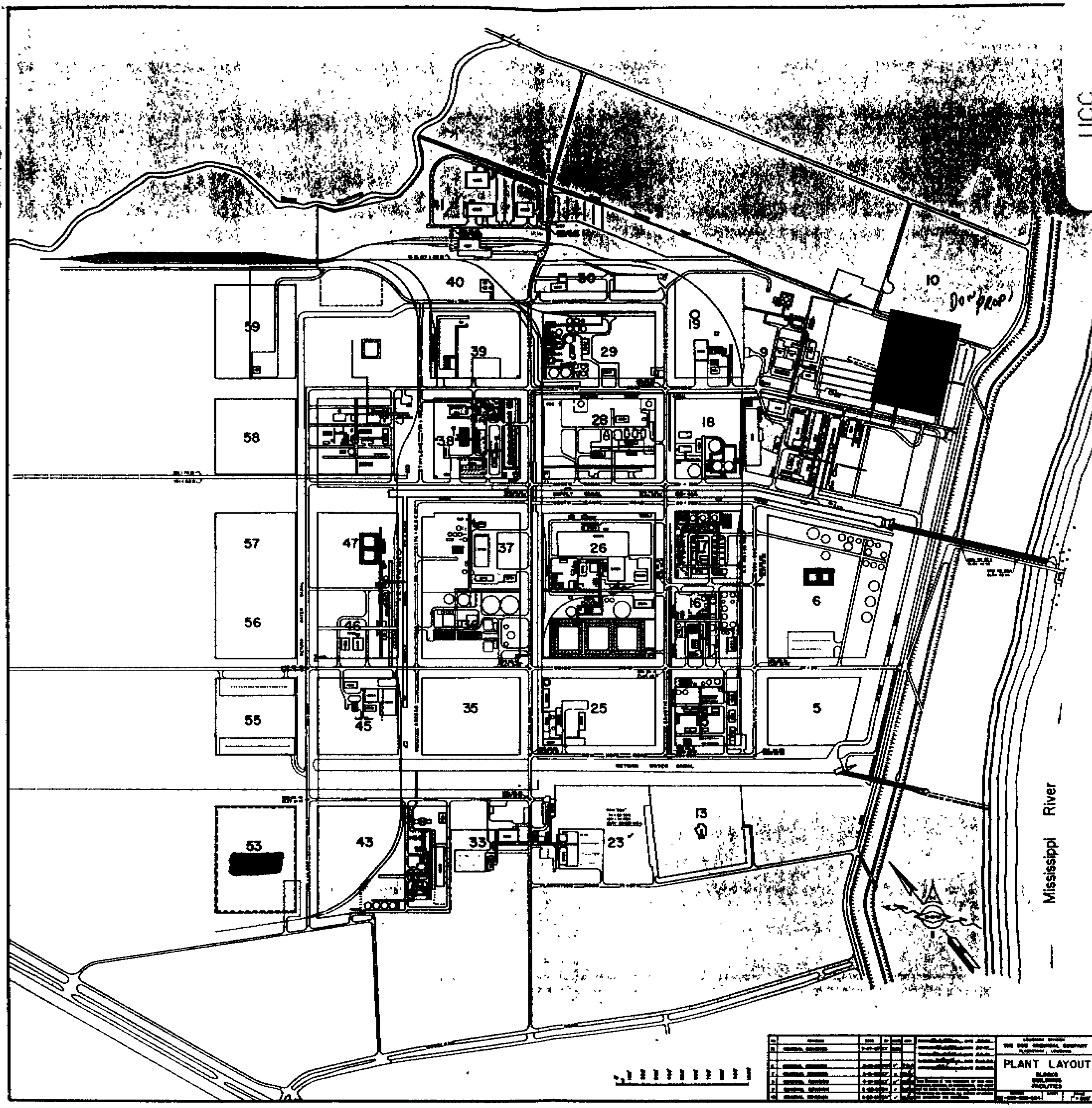
Jean-Claude Thomas attended the Ecole Nationale Superieure de chimie and the Sorbonne University in Paris, France, from which he received several grades in chemistry and chemical engineering, equivalent to PhD. Mr. Thomas joined the Saint-Gobain Co. in 1957 where he has been concerned with the study of the bulk polymerization of vinyl chloride and the development of the new resins. He is currently assistant manager of PVC research and development at Pechiney-Saint-Gobain.

LOCATION AND PROPERTY DESCRIPTION

Dow's PVC plant is located on an 8.6 acre tract situated in the northeastern corner of the Louisiana Division. It fronts on Louisiana Highway 988 -- locally referred to as the River Road -- and has access to Louisiana Highway 1 by two different routes -- Louisiana Highway 1143 to the south and Addis Lane to the north. All of these are two-lane, hard-surfaced roads. Louisiana 1 is a four-lane highway connecting Plaquemine and Port Allen and ties into the Interstate 10 highway system and new six-lane Mississippi River Bridge just south of Port Allen.

The PVC plant site includes:

- Office, laboratory and control room building with locker room, showers, instrument shop, etc.
- A polymerization structure housing one PREPO and four POPOs. Easily expandable to double capacity.
- Monomer storage facilities and recovery equipment.
- Material transfer systems capable of handling double the present polymerization capacity.
- Finishing structure for screening and transferring resin.
- Warehouse and bag, drum, or box packaging station.
- Bulk silos and bulk car or truck loading stations.
- Motor control center building.
- Catalyst storage building.


PLANT LAYOUT
Mississippi River
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Dow PROP
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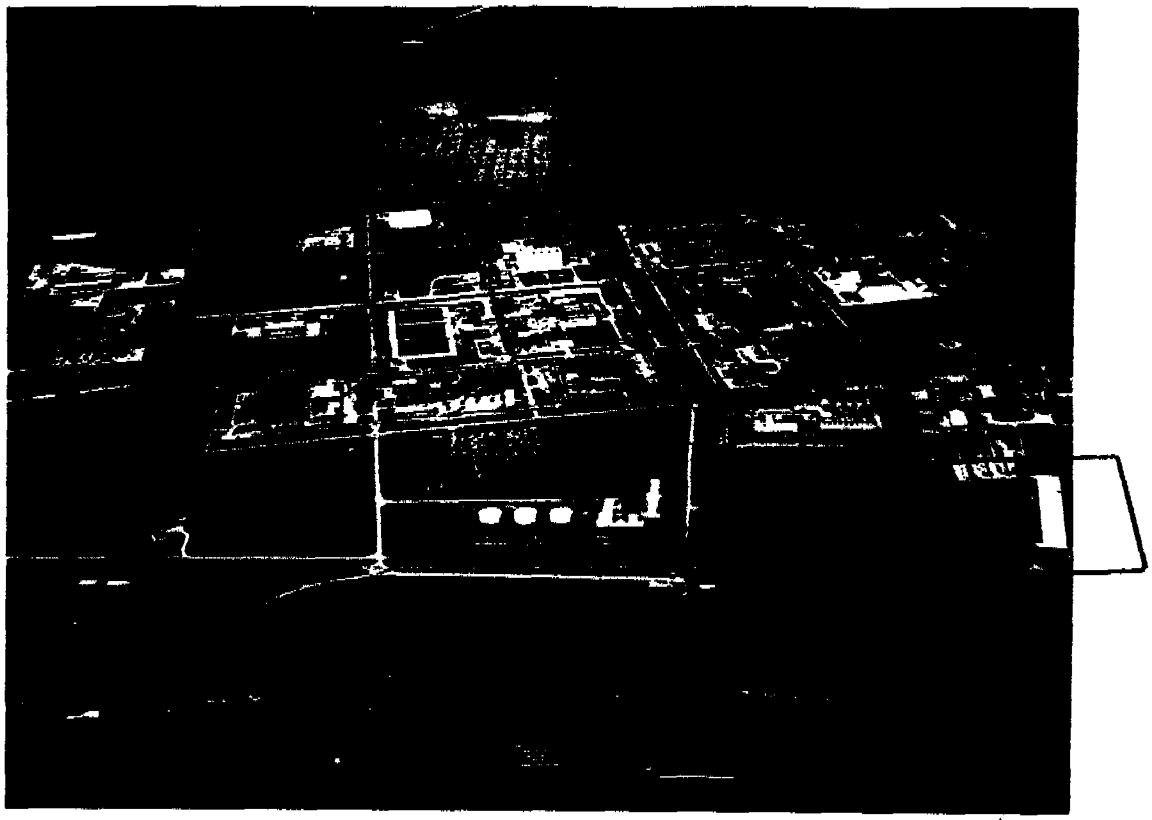

AERIAL VIEW, DOW LOUISIANA DIVISION. PVC PLANT SITE IS LOCATED IN MARKED AREA AT RIGHT. HIGHWAY 1, UPPER LEFT CORNER (GOING RIGHT TOWARD BATON ROUGE) IS APPROXIMATELY NORTH.

THIS PHOTO OF THE PVC PLANT WAS TAKEN FROM A SPOT NEAR THE "X" IN THE LOWER RIGHT CORNER ON THE MISSISSIPPI RIVER LEVEE.

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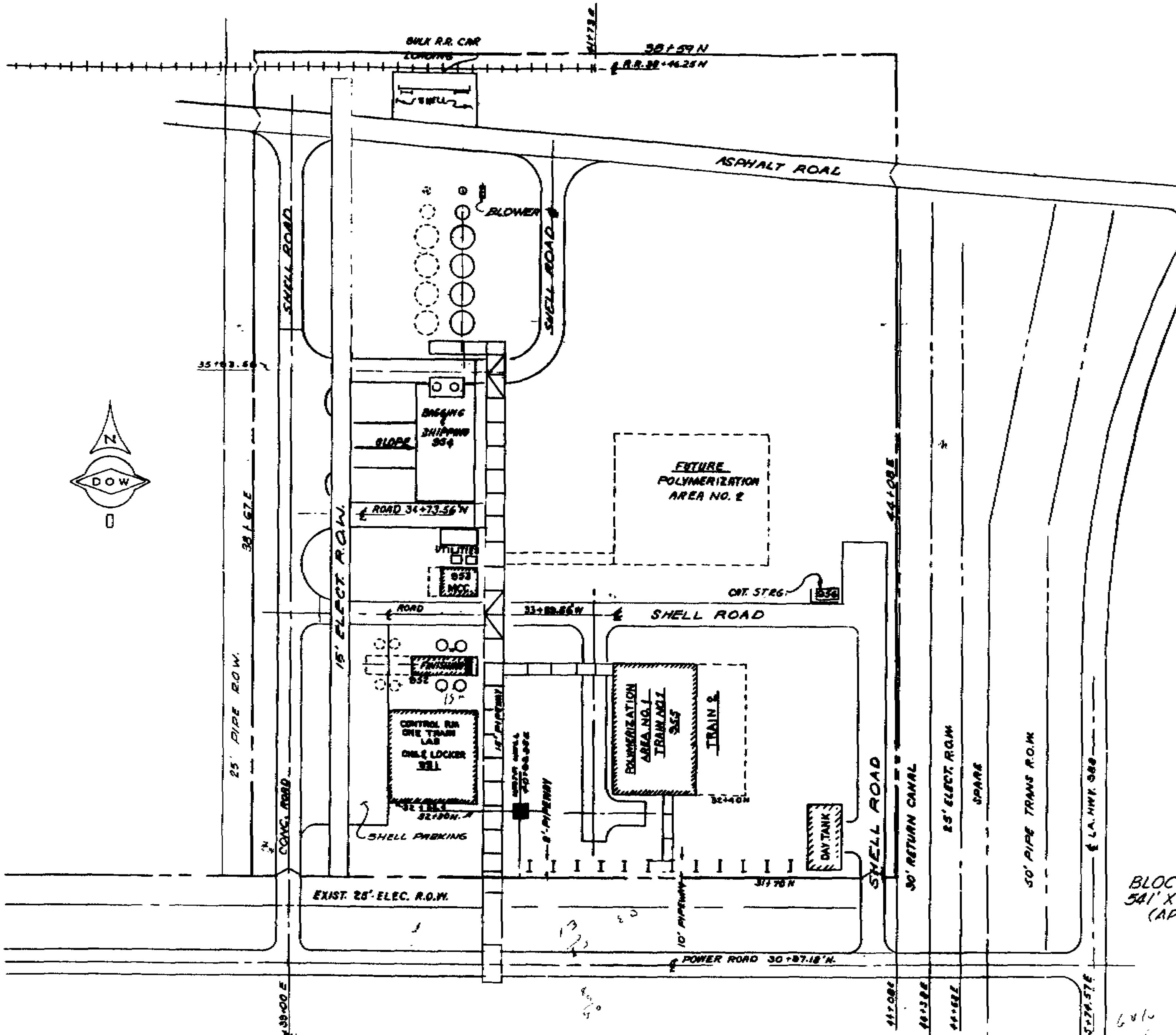


P.V.C. PLANT PLOT PLAN

BLOCK SIZE:
541' X 689' - 8.56 ACRES
(APPROX.)

SERVICES

Concurrent with its growth, Dow's Louisiana Division has developed a comprehensive set of supporting services for its operations. Since some of these services would be beneficial in the operation of the PVC plant, Dow's management is willing to discuss arrangements with and negotiate contracts to supply these services to prospective owners. Examples of services which could be supplied are fire protection and potable, water, steam and power, natural and LPG gas, air, nitrogen, docking facilities, and railroad spurs.

Dow's management is also willing to provide consultation on its salaried operations and contract maintenance programs and also consulting service on such items as local and state tax structure and procedures, prevailing business and political climates, and state statutes regarding waste disposal and the procedure for obtaining waste disposal permits.

INDUSTRIAL COMMUNITY

Existence of the growing Baton Rouge industrial community offers advantages in that the close proximity of Baton Rouge, Geismar, and West Bank complexes permit effective operation of industrial supply houses, supporting service facilities, and such organizations as Mutual Aid and Baton Rouge Industrial Contractors Association. The Baton Rouge-New Orleans-Lake Charles area has been recognized during the past few years as one of the most competitive areas in the United States in regard to industrial suppliers. This competition, together with a freight advantage from eastern and mid-western manufacturing centers, results in relatively low prices for maintenance material and supplies compared with other Gulf Coast locations.

To give you an idea of the growing industrial community, a map of the industrial development of South Louisiana is supplied at the back of this brochure.

Labor Climate

A plentiful supply of trained technicians as well as professional, clerical, construction, and unskilled labor has been a significant asset to Louisiana.

The following wage and salary figures are indications of the going in-plant rates in the Baton Rouge area. It is pointed out that Dow uses predominately contract maintenance personnel based on construction labor rates (see page 19). This service is available from several local contractors, and has proved to be very satisfactory.

Salaried Personnel:	Foreman	\$650-1,000
	Draftsman	\$500-800
	Secretary	\$350-600
	Clerk	\$300-550
Hourly Personnel:	Pipefitter	\$3.68-4.07
	Electrician	\$3.68-4.07

Machinist	$3.68-4.07
Painter	$3.58-4.05
Operator	$3.64-4.35
Ass't. Operator	$3.56-3.85
Lab. Ass't.	$3.55-3.95
Laborer	$2.47-3.02

Both skilled and unskilled labor are generally represented by unions, with most major unions having chemical plant contracts in the area. Although, as pointed out earlier that the Louisiana Division of The Dow Chemical Company does not have a union, craftsmen employed by Dow's maintenance contractor are union members.

Baton Rouge and New Orleans have a number of experienced general contractors capable of chemical plant construction, supported by numerous subcontractors, fabricators, and building material outlets. The manpower level has been adequate, although the high level of construction activity has caused some shortage in certain crafts. Construction labor rates in the Baton Rouge area at this time are as follows:

	Rates/Hour	Contract Expires
Asbestos Workers	$ 5.300	6/6/69
Boilermakers	5.500	5/9/69
Bricklayers	5.100	3/31/69
Carpenters	4.675	3/31/69
Cement Masons	4.225	3/31/69
Electricians	5.900	3/31/70
Ironworkers	5.475	3/31/70
Laborers	3.070	3/31/69
Millwrights	5.325	6/30/69
Painters (Industrial)	4.675	4/30/69
Plasterers	4.425	3/31/69
Pipefitters	5.200	3/31/69
Roofers	4.235*	12/31/69
Sheet Metal Workers	5.425	7/31/69
Teamsters (Pickup Truck)	3.150	3/31/69
Operating Engineers (Heavy Duty)	5.000	3/31/69

* $4.365/hour effective 7/1/69

Louisiana's terrain is generally flat and presents no serious construction difficulties. Soil profile in Dow's industrial site area consists of about 95 feet of fine-grain alluvial soils underlaid by several hundred feet of dense sand and gravel.

Taxes & Political Climate

Louisiana's three greatest natural assets for industrial growth are (1) wealth of basic raw material resources (2) abundance of fresh water, and (3) transportation focal point between the mid-section of the United States and world markets. This unique combination is unequaled in the chemical industry. However, the current level of activity in the state was most probably catalyzed by a fresh, new political climate that is highly favorable to industry. Out of this has come a business-oriented set of amendments to the Louisiana Constitution that was enacted by the State Legislature in 1964 and overwhelmingly approved by the people of Louisiana in the November 3, 1964, general election. Moreover, the confidence of Louisiana industry in future action of state and local government is supported by the awareness of the people of the state in the importance of a healthy industrial climate as a means to economic growth. Organizations such as Public Affairs Research Council and Council for a Better Louisiana, non-profit organizations dedicated to improving state and local government, have been effective in educating the public in such issues.

The 1964 amendments are appropriately called "Louisiana's Right-To-Profit Laws", and are fully described in the booklet by that name. They include laws to create industrial park areas, to establish a state code of ethics, and to prohibit regulation of industrial gas sales. Probably the two most significant, however, reduced the gas severence tax and assured fair property tax treatment after the ten-year exemption period.

The 10-year ad valorem tax exemption program administered by the Department of Commerce and Industry applies to all state and local millages and is one of the most generous industrial exemption programs in the United States. Millage rates in Iberville Parish, for example, are about 50 mills per dollar assessed valuation with probable assessments at a rate of less than 20 per cent of gross cost, resulting in an estimated ad valorem tax cost of less than 1.0 per cent of gross capital per year. Tax savings during the 10-year exemption period for a $10 million investment, at these rates, would be about $1 million.

Dow's plant site has been included in an "Industrial Area" recently created by the local parish (county) consistent with recently enacted state legislation. This will protect Dow as well as potential neighboring industries from future taxation on certain services which industry provides for itself (fire protection, waste disposal, etc.).

Transportation

The Louisiana ports provide a natural rail-truck-marine interchange point for goods moving to and from much of the North American mid-continent and world ports. The Port of New Orleans is the nation's second largest and includes about 25 miles of wharves, storage sheds, and other waterfront installations including a 20-acre Free Trade Zone. The Port of Baton Rouge has grown since 1957 to a $40,000,000 modern facility equipped to handle a variety of goods and commodities. Baton Rouge is the furthest inland deepwater port on the Mississippi River, which has contributed to its growth as the nation's seventh largest port. Although located over 200 miles from the Gulf, the conference steamship rates from Baton Rouge to all the world ports are no higher than from any other Gulf port. This facility is located approximately 10 miles from the Dow property.

The mouth of the Mississippi River is the hub of the nation's inland waterway system, and is serviced by nearly all major barge lines operating on the Mississippi River. The frequency of river tows provides excellent competitive service to points on the inland waterway system.

The area is well serviced by a variety of rail and motor carriers. Baton Rouge alone has four major railroads and more than twenty truck lines serving the city. Because of its inland location, Baton Rouge enjoys faster service and lower freight rates to and from eastern and mid-western areas than other Gulf Coast locations. Low rates are encouraged by competition between the different modes of transportation.

Dow property is served by the Texas and Pacific Railway Company's main line. The T & P has provided excellent transportation in terms of both rate making and service.

Utilities, Waste Disposal and Services

WATER - The Mississippi River provides the Baton Rouge area with its greatest natural asset. The 180 million gallon per minute average mean flow provides an unequaled supply of good quality fresh water for cooling, raw material, navigation, and waste disposal purposes. Fresh water is also available from extensive ground water supplies of varying degrees of quality so that Louisiana's "Chemical Strip" is not threatened by drought conditions that frequently occur on most rivers or by depleting underground water tables.

Ground water in the area is abundantly available at a depth of between 200 and 400 feet. Large capacity wells (over 6,000 gpm) can be economically installed and operated with no significant "draw-down" effect or quality deterioration.

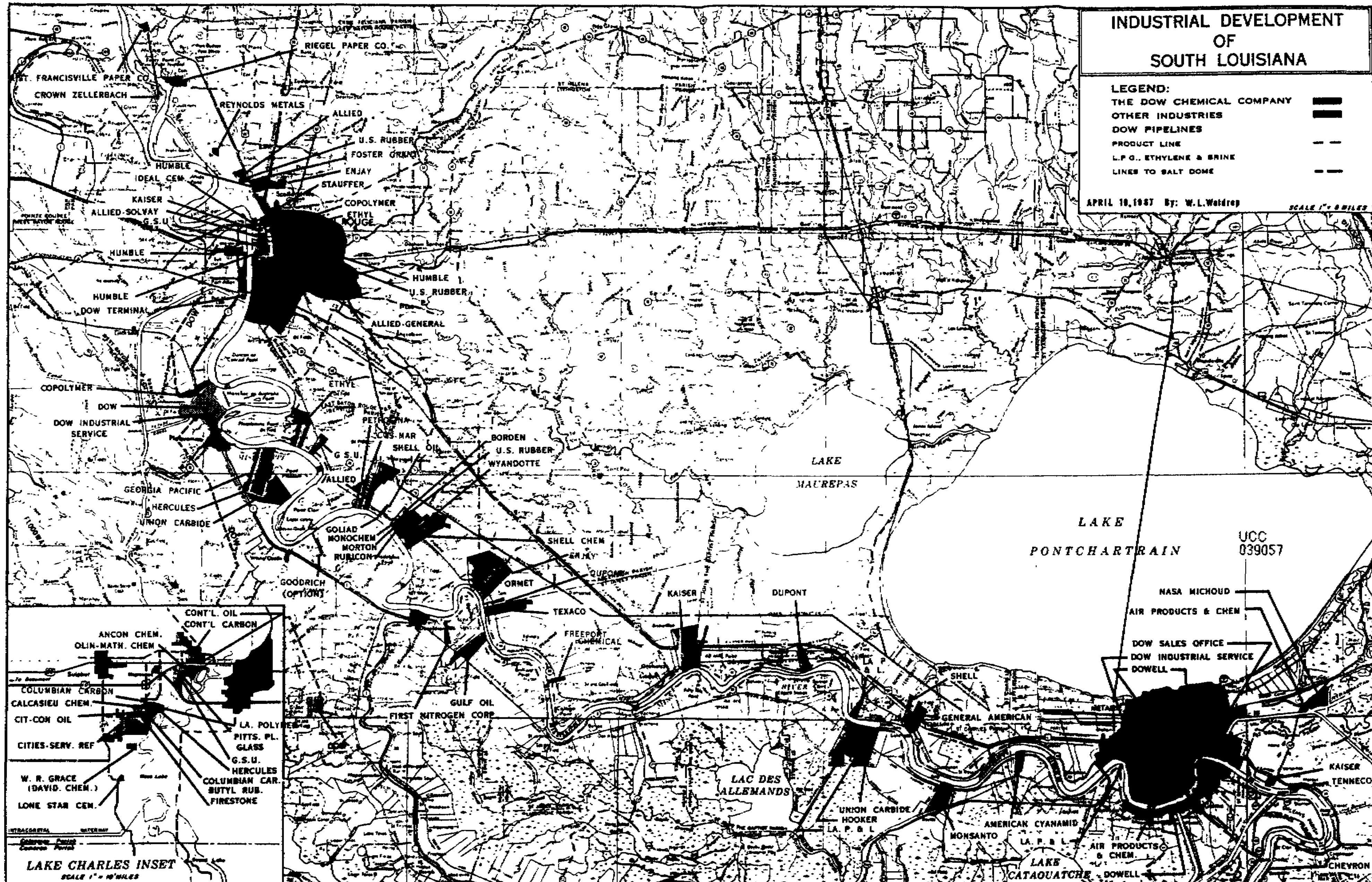
POWER - Baton Rouge and the upper portions of the "Chemical Strip" are supplied by Gulf States Utilities Company with a system generating capacity approaching 2,000,000 KW. The downstream portion of the area is supplied by Louisiana Power & Light Company.

FUEL GAS - With Louisiana's tremendous reserve of natural gas serving as a base, the state is criss-crossed with distribution pipelines providing low cost fuel gas to consumers on a competitive basis. The Dow property is served by two pipeline suppliers (Humble and Texaco).

WASTE DISPOSAL - The volume of Mississippi River water, even during periods of low flow, is sufficient to permit disposal of certain industrial wastes that would otherwise require higher capital and/or operating costs. The Louisiana controlling authority on waste disposal is the Louisiana Stream Control Commission. Dow will provide a pipeline right of way across Dow property to the Mississippi River for waste disposal pipelines. Waste Streams would be subject to the approval of the

Louisiana Stream Control Commission and would be the responsibility of the originating company.

SERVICES - Certain services could be made available by Dow on a negotiated or shared cost basis. Arrangement could also be made for others to participate in the contract delivery service that is used as a part of our vendor stock program. This service provides for use of two delivery trucks and permits three deliveries a day from Baton Rouge.



INDUSTRIAL DEVELOPMENT
OF
SOUTH LOUISIANA
LEGEND:
THE DOW CHEMICAL COMPANY
OTHER INDUSTRIES
DOW PIPELINES
PRODUCT LINE
L.P.G., ETHYLENE & BRINE
LINES TO SALT DOME
APRIL 18, 1967 By: W. L. Waldrep
ST. FRANCISVILLE PAPER CO.
CROWN ZELLERBACH
RIEGEL PAPER CO.
REYNOLDS METALS
ALLIED
U.S. RUBBER
FOSTER GRANT
ENJAY
STAUFFER
COPOLYMER
ETHYL
HUMBLE
IDEAL CEM.
KAISER
ALLIED-SOLVAY
G.S.U.
HUMBLE
HUMBLE
DOW TERMINAL
HUMBLE
U.S. RUBBER
ALLIED-GENERAL
ETHYL
COPOLYMER
DOW
DOW INDUSTRIAL SERVICE
COS-MAR
SHELL OIL
G.S.U.
ALLIED
BORDEN
U.S. RUBBER
WYANDOTTE
GEORGIA PACIFIC
HERCULES
UNION CARBIDE
GOLIAD
MONOCHEM
MORTON
RUBICON
SHELL CHEM
ENJAY
GOODRICH (OPTION)
ORMET
TEXACO
FREEPORT CHEMICAL
GULF OIL
FIRST NITROGEN CORP.
KAISER
DUPONT
LAKE MAUREPAS
LAKE PONTCHARTRAIN
UCC 039057
NASA MICHOUD
AIR PRODUCTS & CHEM
DOW SALES OFFICE
DOW INDUSTRIAL SERVICE
DOWELL
SHELL
GENERAL AMERICAN
LAC DES ALLEMANDS
UNION CARBIDE
HOOKER
LA. P. & L.
MONSANTO
AMERICAN CYANAMID
LA. P. & L.
AIR PRODUCTS & CHEM.
LAKE CATAOUATCHE
DOWELL
KAISER
TENNECO
CHEVRON
CONT'L. OIL
CONT'L CARBON
ANCON CHEM.
OLIN-MATH. CHEM
COLUMBIAN CARBON
CALCASIEU CHEM.
CIT-CON OIL
CITIES-SERV. REF
W. R. GRACE (DAVID. CHEM.)
LONE STAR CEM.
LA. POLY
PITTS. PL. GLASS
G.S.U.
HERCULES
COLUMBIAN CAR.
BUTYL RUB.
FIRESTONE
LAKE CHARLES INSET

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In November 1964, we were told the following by PSG:

"There were two differences mentioned that could possibly limit the desirability of bulk polymers. First, the electrical properties are not as good as suspension in the same formulation. The bulk polymer measures 0.85 - 1.5 megaohms at 500 volts, 60°C. after 3 hours in water while the suspension resin measures 1-2.0 megaohms. Actually P.-S.G. sells a modified (filled) suspension resin which measures 6-10 megaohms. Second, the bulk polymers are not interchangeable with suspension polymers in all formulations."

Mass resins which were subsequently evaluated by U. S. customers apparently met customer specifications. We doubt if the above is a problem today.

DOW MASS PVC

Office Building:

one story 70 X 70

Air conditioned, control room, six offices, receptionist area, equipped quality control laboratory, instrument shop, restrooms, showers, locker rooms, conference room.

Polymerization Structure: 65 X 80

1 - Prepo, 1850 Gal., 316 S. S. Clad.
4 - Popos, 4200 Gal., 316 S. S. Clad, with external condenser, 225 psig., 650 mm Hg., drive train and agitators, reactor slab weigh systems.
1 - Sulzer recovery compressor system.
1 - Nash vacuum pump.
Filters in degassing system.

Safety - Open deluge system; open building construction; VCL detectors and alarms; Class I, Division I, Group D code, lockouts on agitators; automatic valves, remote control room (100'); reactor vents 20' above roof.

VCL Storage and Recovery:

25 X 50

VCL pumped into 17,000 gal. day tank; water cooled condenser, vent condenser cooled by propylene refrigeration system; VCL pump to Poly area; VCL purification - filters and caustic; open structure; deluge; Class I Division II, Group D code.

Finishing Structure: 50 X 15

70' high; 5 levels; freight elevator; mostly open structure.
Transfer systems:
- Hoffman vacuum blowers to pull resin — MCC - 27 X 22
- Semco pot system for resin transfer

Screens:
- 2 Sweco scalpers
- 2 Derrick finishing screens

1 - Young grinder
1 - Schultz O'Neil mill
Grate magnets, automatic samplers
Quarantine storage

Warehouse and Bagging:

5000 ft.^{2} (1/3 for maintenance shop) 45 X 90
Move product out to leased warehouse daily.
3 - Spout Crown Zellerbach baggers

UCC
039059

Bulk Storage and Loading Stations:

4 - 0.5 $\overline{M}$ # epoxy coated steel silos.
1 - Flotronics gravity blender
1 - RR car loading station and spur
1 - Bulk truck loading station

Catalyst Storage:

600 ft.^{2} walk-in cooler; stainless steel inside and out; dual refrigeration units; concrete protection wall; 125' from Poly structure; 17 ft.^{3} chest freezer in Poly structure.

Plant Utilities

Electrical: Motor control center; 2 - 1000 KVA transformers; 2 - 2300 volt feeders from two different sources (substations); automatic cross-tie; emergency 48 V. D-C battery system for control panel.

Cooling Water: 3500 gpm deep well; 72°F $\pm$ 1°F year round; one pass to effluent ditch; emergency cross tie to plant process and fire protection water.

Nitrogen: 150 psig from N_2 plant.

Air: Joy 3-stage centrifugal compressor; 100 psig at 2600 CFM.

Steam: 235# from power house; no condensate return.

Potable Water and Sewers: Dow system

Operations

Similar to suspension process.
Two step process.
Sequentially programmed controls.
Normal pressure and temperature controls.
BTU counter.
Load Cell weigh system.
Reactor cleaning:
  Popo-every batch.
  Prepo-every 4th batch.
  Contract Laborers
Low temperature initiators.
Recovered VCL mixed with feedstock.
Heat sensitivity problems greater.

Finishing:

Five systems with local control, Semco transfer pots combined with hoppers, Hoffman vacuum blowers, screens, bag filters.

14m Initial product transfer.
14m Initial receiving and scalping.
Prime product screening and transfer.
Second quality two-stage grinding.
Second quality screening and transfer.

Capacity:

K value = 65; ASTM IV 0.92.
P-SG guarantee: 30 $\overline{M}$#/yr.
P-SG optimum prepo usage: 34 $\overline{M}$#/yr.
÷ Dow confident of 42 $\overline{M}$#/yr., add another prepo if needed

Manpower:

1 - Superintendent
1 - Assistant Superintendent
1 - Quality Control Supervisor
1 - Operations Supervisor
4 - Shift Supervisors
4 - Control Board Operators
3 - Vacation and overtime Relief Operators
4 - Reactor Operators
4 - Finishing Operators
4 - Utility Operators
21 - ~~5~~ - Quality Control Technicians
1 - Clerical
C - 8 - Reactor Cleaners
C - 2 - Packagers
C - 1 - Janitor
44 - Total

ADD 4 PEOPLE FOR DOUBLE CAPY CLEANER

10 PEOPLE

$2500 M - 114