COMPANY CONFIDENTIAL

RESEARCH AND DEVELOPMENT REPORT
ANNISTON PLANT

Report No. 1
Job No. 370-501
Date 6-20-67

OTHER LOCATIONS	GENERAL OFFICE	ANNISTON PLANT
J. R. Savage - JFQ	D. B. Hosmer	W. B. Papageorge
W. R. Kellogg - Nitro	H. C. Carder	E. C. Fuhrmeister
W. J. Wilson - WGK	D. Danna (3)	H. L. Williams
J. F. Quinn - So. 2nd	P. G. Benignus	C. K. Eastman
M. E. Gibbs - So. 2nd	H. O. Hehner	V. R. Haupt
D. C. Armstrong - WGK	R. P. Stevens	J. MacPherson
H. Ray - WGK	R. S. Yates	G. W. Miller
J. W. Molloy - WGK		W. B. Dunlap

Title: Aroclor 1242 - Shipping Containers

Personnel: E. G. Wright and J. G. Bryant
Reported by J. G. Bryant

Problem: Find a storage container to hold the electrical properties of Aroclor in transit

Justification: To meet foreign competition

Summary: The objection (poor impact resistance) to the present drum (clear phenolic lined) used for transporting Aroclor has been overcome with a Dalbon lined drum. The Dalbon lining is an electropositive surface which has retained Aroclor 1242 for thirty days at a 60 cps Power Factor of 0.1% and a Resistivity of 24,000 x 10^9 ohm cm. The application cost of the liner is greater than the present liner. However, possibilities for lowering the application cost are being investigated. To date, the price comparison is $11.90 vs $8.05 for the present container. This compares to $13.53 for a hot dipped galvanized drum which Bayer is using.

A second alternate tested which is very promising and economical was a double coated epoxy phenolic impregnated with Porocel. This yielded a 60 cps Power Factor of 0.13% and a resistivity of 11,200 x 10^9 ohm cm. The application cost for this is $8.60 a drum. The only objection is the presence of small amounts of loose adsorbent in the drum contents.

Experimentation has indicated a drum flush is necessary. A suitable system design is being prepared. We believe with an adequate flush a suitable container can be developed at little or no added increase in price.

Besides testing for the most economical container, we plan to obtain data on transit results or mechanical stress on the liner.

James G. Bryant

/dp

DSW 375292

STLCOPCB4099061

Background

At the issuance of the last progress report on containers, Anniston PR&D 370-322, No. 11, 11-28-66, a double coat phenolic (4A) lacquered drum was recommended. Recognizing the limitations of the phenolic lining (poor impact resistance), we continued our search for a more applicable container. In Report No. 11, we outlined under "Future" the program which we followed. Experimental conditions were to evaluate hot dipped galvanized, Dalbon, a combination epoxy phenolic and clear phenolic, confirm double coat clear phenolic, evaluate flush on the drums, and investigate methods of additives (such as Porocel) for retaining electrical properties. All testing to date has been conducted under static conditions (no transit of drums to test lining failure from mechanical stress).

Experimental

A high quality lot of Aroclor 1242 was produced in the plant to fill all the respective drums. The drums were filled as received from the factory. They were not rinsed.

The highest quality material was retained in a double coated Dalbon lined steel drum. See Table I (data) for the storage. The Dalbon is an electropositive surface coating which refines the electrical properties of Aroclor in storage. The surface charge of the coating was confirmed by the use of a high voltage charged grid. The surface charge is the same as that of the adsorbents. The Dalbon liner has a tremendous impact resistance equaled by no other type liner. As expected, the major disadvantage is the cost. The cost can be lowered about one-half by a single application, if proper coverage of the steel can be achieved.

The second best type of liner was a bauxite impregnated epoxy phenolic (pigmented) liner. One coat of pigmented epoxy phenolic (Series 46) was applied to the steel container and dried. A second coat was applied and while the drum was spinning the coarse (20/60 mesh) Porocel was applied to the coating and dried with most of the Porocel surface exposed. Once the drums were filled with Aroclor the quality continued to upgrade due to the surface coating. This is the same effect of the Dalbon but at a considerable reduction in cost of application. The application cost may be further reduced by using only one coat of epoxy phenolic, if the bare metal left exposed when a particle breaks away can be tolerated. The major disadvantage in either case is the floating particles resulting from adsorbent breaking away from the surface.

The third best approach is adding clay directly to the drum contents. This holds the quality but there is no particular price advantage. The major disadvantage is that all the adsorbent is floating in the contents of the drum and insertion of the powder is time consuming and messy. Also, at the St. Louis Divisional Meeting in May there was an expressed desire to avoid adding powder directly to the drum contents.

A fourth approach is changing to an epoxy phenolic lining for added impact resistance. This is a Bradley and Voorman Series 46 coating which is 70% epoxy and 30% phenolic. This is not to be confused with the epoxy phenolic tested by MCL (Newport Job No. 27/7130/1686, Report No. 4, 10-17-66) which was 30% epoxy and 70%

STLCOPCB4099062

Experimental (continued)

phenolic. The major difference between the two is the epoxy concentration. The higher the epoxy concentration, the greater the impact resistance. The epoxy phenolic overcomes the poor impact resistance of the clear phenolic but it does not offer the improved refinement in storage as that of Dalbon or the impregnated liners. The cost of the epoxy phenolic is identical to that of straight phenolic.

Discussion of Results

Experimentation has indicated that a drum flush is necessary in maintaining the quality objective we have set. In all cases, the quality took an initial drop when the drums were filled. This is indicative of what happens even in glass until the surface is conditioned. We know that once the surface of the glass is conditioned the electrical properties of the Aroclor will hold stable. The same should hold true for a liner, providing the liner does not adversely affect the electrical properties or break up under mechanical stress.

All tests conducted have been aimed toward obtaining the best container for maintaining quality at the cheapest price. Present data indicates the best quality material is maintained in a double coat Dalbon lined container. The material takes an initial drop but recovers due to the electropositiveness of the Dalbon surface. The impact resistance of the Dalbon is the highest of the plastic liners. The only objection to the Dalbon is the extremely expensive application cost. We believe a single coat of the Dalbon would yield adequate protection. If so, the application cost would be cut in half. Even with cutting the cost in half, the application cost of Dalbon is considerably higher than the epoxy phenolic, impregnated, or non-impregnated.

The impregnated (Porocel) epoxy phenolic maintains a quality close to that of the Dalbon. The big objection to the impregnation is the floating particles of adsorbent in the Aroclor. Regardless, some of the particles will break off the surface and be present in the contents. The only liner which accepts the impregnation is the epoxy phenolic (Bradley and Voorman Series 46). The impact resistance of the epoxy phenolic is considerably greater than that of the clear phenolic but not as good as the Dalbon.

We believe the epoxy phenolic will answer the need, providing it is given a thorough flush prior to filling. No upgrading would be expected but with adequate flushing none should be needed. The added impact resistance should solve liner failure during transit which is a problem with the present phenolic lined drum. However, if the flushed liner does not do the complete job it could still be impregnated.

Present knowledge leaves us with Dalbon as the most suitable liner for a high quality storage container, free of any particles. The second alternate for highest quality would be the Porocel impregnated epoxy phenolic liners. The third and cheapest alternate would be the use of an epoxy phenolic to replace the present liner.

We plan to continue the investigation to obtain the most suitable type container at the cheapest price. Until we get additional data the recommended containers remain (1) double coat Dalbon, (2) impregnated double coat pigmented epoxy phenolic (Series 46), and (3) double coat pigmented epoxy phenolic.

DSW 375294

STLCOPCB4099063

Discussion of Results (continued)

Depending on the type liner we can find satisfactory and the effect of the drum flushing we may be able to hold the cost at the present level, or even lessen the cost. Until this is accomplished we could use one of the more expensive methods to bridge the gap. Even if we must use the Dalbon liner we may be able to lower this to a competitive price range of the present container. See Table II for a comparison of the costs.

Containers Used by Competition to Deliver High Quality Aroclor

The container used by Bayer to deliver high quality Aroclor is a hot dipped galvanized. German patent No. 938741 covers the treatment of containers for Aroclor. We feel they are using an additive or coating for two reasons: (1) our attempts with a plain hot dipped galvanized container have not shown the same quality level as the Bayer material and (2) analysis in Organic Research confirms the use of an additive (ref. letter R.E.K. to J.G.B. 4-21-67). The analysis was made from a white milky deposit found in the bottom of the drum.

Importance of Reduction in Lining Cost for Drums

The Anniston Aroclor Department ships 30,000 drums/yr. at the present rate. Any lining change more satisfactory than the present will likely be adopted by W.G.K. Aroclor Department, also. A difference of 3 to 4 dollars in drum cost for Anniston is a 100 - 120 thousand dollar cut in profits. For this reason the selection of the best liner for the least cost is advantageous.

Conclusion

1. The best liner for maintaining highest quality Aroclor is double coat Dalbon.

2. The hot dipped galvanized container similar to the one the Germans are using does not offer any advantage over Dalbon lined and costs considerably more.

3. The epoxy phenolic liner impregnated with Porocel is satisfactory for holding high quality Aroclor if particles can be tolerated in the contents. It is considerably more economical than Dalbon and offers improvement over the clear phenolic presently used.

Recommendations

1. For shipment of the highest quality Aroclor free of particles, the container is a double coated Dalbon.

2. A more economical container with a few floating particles is the Porocel impregnated epoxy phenolic.

3. Continue the investigation to obtain an adequate drum flush.

STLCOPCB4099064

Future

The primary objective in the container test program has been to obtain the most suitable container at the most economical price. Although the story may appear confusing, we have conducted an extensive evaluation of lined and non-lined containers. A satisfactory container has been found and other possibilities are available. The objective now is to determine the most economical solution. The field has been narrowed to the epoxy phenolic and the Dalbon type liners. We need to determine the most economical method by various combinations of these types of liners.

The test program will involve testing single and double coat applications of Dalbon and epoxy phenolic linings. The epoxy phenolic will be tested in clear and pigmented; impregnated and non-impregnated. Additionally, drum flushing will be tested to see what is needed.

Once we obtain a satisfactory drum flushing technique, we feel the epoxy phenolic may answer the need without any additional expense or if there is an added expense it would be only for the pigmentation. Table III gives a comparison of the cost and characteristics of the various lining conditions.

An automated drum flushing system is being designed. The system will utilize commercially available equipment. Prior to issuing a project we plan to determine the quantity of flush needed.

James G. Bryant

James G. Bryant

/dp

STLCOPCB4099065

Table I

Data

Aroclor 1242 Test Drum Results (Static Conditions)

Power Factor (P.F.) - 60 cps @ 100°C
Resistivity (Resist.)- x 10^9 ohm cm @ 100°C

Aroclor 1242 Feed stock used in the test

Location of sample	Power Factor	Resistivity
Filter Press	0.19	48,000
Process Line	0.36	19,200
Drum (4A phenolic)	0.24	20,000

Condition	Date							
	4-21-67		4-27-67		5-2-67		5-25-67	
	P.F.	Resist.	P.F.	Resist.	P.F.	Resist.	P.F.	Resist.
Present standard drum Clear phenolic (4A) double coat	0.72	3,600	0.50	4,800				
Pigmented epoxy phenolic (70/30) double coat	--	--	--	--	--	--	0.13	3,900
Galvanized (hot dipped)	0.49	6,600	0.45	10,000				
Aluminum	1.14	2,400	--	--				
Pigmented Dalbon double coat	0.36	12,800	--	--	--	11,200	0.07	24,000
Drum Liners Impregnated or Additive								
Clear phenolic single coat with 0.1% attaclay additive	--	--	--	--	0.36	8,000		
Clear phenolic single coat with 0.2% attaclay additive	--	--	--	--	0.27	10,400		
Pigmented epoxy phenolic double coat impregnated with coarse Porocel	0.66	4,000	0.54	9,200	0.42	9,600	0.13	11,200
Pigmented epoxy phenolic double coat impregnated with coarse attaclay	0.72	2,800	1.0	2,700	0.46	6,080		

DSW 375297
STLCOPCB4099066

Table II

Cost Data

Type of Liner	Liner Cost Dollars	Base Drum Dollars/drum	Lined Drum	Additive Cost Dollars	Complete Dollars/drum
Hot dipped galvanized (18 gauge)	- -	- -	- -	- -	13.53
(16 gauge)	- -	- -	- -	- -	15.03
Base Drum	- -	6.90	- -	- -	- -
Single coat clear phenolic (4A) or epoxy phenolic (Series 46)*	0.65	6.90	7.55	25	7.80
Double coat clear phenolic (4A) or epoxy phenolic (Series 46)*	1.15	6.90	8.05	25	8.30
Single coat pigmented phenolic (4A) or pigmented epoxy phenolic**	.80	6.90	7.70	25	7.95
Double coat pigmented phenolic (4A) or pigmented epoxy phenolic**	1.45	6.90	8.35	25	8.60
Single coat Dalbon	2.50	6.90	9.40	***	9.40
Double coat Dalbon	5.00	6.90	11.90	***	11.90

* Epoxy phenolic is 70% epoxy and 30% phenolic

** Pigmentation is TiO_2. This is made by two processes, sulfate and chloride. The chloride should be avoided because it most likely can affect the stability of the Aroclor.

*** Dalbon is pigmented with a Fe and tests have shown that impregnation is not necessary since the Dalbon coating demonstrates a surface charge similar to the adsorbent.

DSW 375298
STLCOPCB4099067

Table III
Drums Listed According to Cost

	Type Liner	Cost Dollar/drum	Characteristics
1.	Hot dipped galvanized	13.53	Similar to the Bayer drum but still needs an additive to hold the quality
2.	Double coat Dalbon lined	11.90	Highest impact resistance - best quality retainer tested to date
3.	Single coat Dalbon lined	9.40	High impact resistance - may not achieve adequate coverage - to be tested
4.	Double coat (pigmented) epoxy phenolic impregnated with Porocel	8.60	Good impact resistance, adsorbent for retaining electrical properties and adequate coverage when adsorbent breaks away from the surface. Next best container to Dalbon lined tested to date.
5.	Double coat pigmented phenolic	8.35	Poor impact resistance and will not take impregnation
6.	Double coat (pigmented) epoxy phenolic	8.35	Same features as No. 4 except no adsorbent for upgrading
7.	Double coat (clear) epoxy phenolic impregnated with Porocel	8.30	Same features as No. 4 except the pigment is lacking so the coats will be thinner but may be perfectly acceptable
8.*	Double coat clear phenolic	8.05*	Unacceptable for same reason as No. 5
9.	Double coat clear epoxy phenolic	8.05	Same features as No. 7 except NO Porocel is present for upgrading
10.	Single coat pigmented epoxy phenolic impregnated with Porocel	7.95	Same as No. 4 except each time the adsorbent breaks away from the surface, bare metal is left exposed. The pigment should give a good thick coat even with one application.
11.	Single coat clear epoxy phenolic impregnated with Porocel	7.80	Same as No. 7 except the single coat may not give adequate coverage

*Present drum being used

DSW 375299

STLCOPCB4099068

Table III (continued)

	Type Liner	Cost Dollar/drum	Characteristics
12.	Single coat pigmented epoxy phenolic	7.70	Same as No. 10 except NO adsorbent for refinement
13.	Single coat clear epoxy phenolic	7.55	Cheapest solution. Same properties as No. 9 - probably will not give adequate coverage with just one coat

STLCOPCB4099069