COMPANY CONFIDENTIAL

RESEARCH AND DEVELOPMENT REPORT
ANNISTON PLANT

Report No. 7
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Title: RESISTIVITY OF AROCLOR 1242

Personnel: J. G. Bryant (L. C. Fuhrmeister)

Problem: Aroclor 1242 electrical properties (resistivity) drop during storage in drums.

Justification: Improve drums for handling Aroclors in order to protect quality and meet competition.

Summary: Aroclor electrical properties drop significantly when the drum liner is damaged. This has been observed both in the laboratory and in the field. Due to recent quality demands, this problem has become increasingly important. A close look at the drum liner will probably explain the quality degradation.

The container presently used for Aroclors is the clear phenolic A lined drum. Bonding of the phenolic lining to the steel is difficult to achieve. For good bonding, the steel surface is blasted and then conditioned with phosphoric acid. The acid treatment leaves clean steel with a coating of iron phosphate. Any grease is removed with a meta phosphate salt. The lining is then sprayed over the phosphate salt and baked to the metal. The phenolic coating bakes to a hard brittle finish, leaving the layer of nonvolatile salt underneath.

The liner cracks and pops away from the steel during the drum fabrication, leaving the exposed salt. When the drums are filled with Aroclor, the salt exposed by the lining cracks, lowers the Aroclor quality. As the drums are dented in transit more salt is exposed, thereby lowering the quality still further. Even metal flexing in transit will cause the brittle phenolic lining to crack and peel off, exposing increasing amounts of salt.

The solution to this problem is elimination of the salt coating and a more flexible lining with improved adherence to the steel. The Bradley and Vrooman series 46 epoxy phenolic lining offers increased flexibility and reverse impact resistance. The steel surface does not require elaborate conditioning. The steel can be cleaned with a solvent leaving no salt for contamination in case the liner breaks. Any residual solvent is volatilized during the baking of the liner.

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Future: Two test drums are being obtained from Nesco to check the storage of electrical grade Aroclor 1242. The steel of the drums will be cleaned with naphtha and coated with the Series 46 Bradley and Vrooman epoxy phenolic lining.

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Technical Services Dept.

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DSW 301748

BACKGROUND:

Quality demands on liquid Aroclors 1242 and 1254 have increased substantially. In order to compete with foreign suppliers better electrical properties (resistivity of 5,000 x 10^9 [min.] vs. present specification of 500 x 10^9 ohm/cm) have been demanded. The present refining and treatment systems are being evaluated to meet the electrical properties demanded.

However, after producing good quality Aroclor, past experience shows that the quality drops with storage in the drums. Other evidence shows that exposure of the Aroclor to clean metals, such as iron and steel, does not lower the electrical properties. This leaves only the drum lining and the effect this could have on the Aroclor.

DETAILS:

The problem in exporting Aroclors to South America is holding the electrical properties (resistivity) of Aroclors in shipment and storage. In order to compete with the Germans, Monsanto needs a cheap drum which will not cause degradation of the Aroclor electrical properties. The Germans are using a zinc plated steel container with rolling hoops. These drums are of rugged construction. The expense of handling Aroclor in zinc drums is high. To start, the drum is four times more expensive than a conventional drum. The drum weight is double that of the ordinary drum which results in a considerable loss in payload. Return of the drum is mandatory so return freight is expensive.

To compete, Monsanto needs a flexible liner which gives when the drum is bent. The steel needs to be clean so that if the liner cracks there will be no contamination. If the steel is clean the liner serves only as a protector for the steel until the drum is filled. Once the drum is filled with Aroclor the steel will not rust. Clean steel does not adversely affect the Aroclor quality.

Drums lined with the phenolic A lacquer lowered the electrical properties as the lining was cracked. A phenolic A lined drum was rinsed with Aroclor numerous times until the quality of the Aroclor from the drum was sufficiently high. Once the quality was high in the drum, the drum was dented with a hammer to break the lining. After breaking the drum lining in the presence of Aroclor, the electrical properties of the Aroclor were lowered significantly. The test, when repeated with several different drums, yielded the same results. See attached data for details.

A close look at the fabrication of the phenolic lined drums will explain the Aroclor degradation. To obtain adherence of the phenolic lacquer, the steel must be throughly cleaned. The cleaning procedure for the steel is the use of phosphoric acid and a meta phosphate salt to clean the surface and leave iron phosphate (salt) exposed to protect the steel until the lacquer is applied. The phenolic lacquer is sprayed over the salt coated steel and baked to a hard finish. The phenolic coating is cracked during drum fabrication. Any additional stretching or bending of the steel causes cracks. The cracks open an area through which the Aroclor can contact the salt. The salt being ionic quickly ruins any electrical properties of the Aroclor. Microscopic analysis reveals that there are considerable areas of exposed salt covered metal in a new drum.

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DETAILS: (continued)

The epoxy phenolic lining offers a solution to the contamination problem. First, the epoxy adheres to the steel easier. Conditioning of the metal is not necessary. Steel cleaning consists only of a solvent wash to remove grease prior to the application of the coating. The epoxy is a flexible coating which would not break up during drum fabrication. Metal bending and stretching would not result in cracked linings. The added cost for the application of the epoxy would be fifteen cents per drum. Two coats would cost seventy to eighty cents additional.

The epoxy phenolic lining appears to be compatible with the Aroclor. Tests with 75% dichloro benzene, which does not differ widely from Aroclor, show a year's exposure with no attack. Aroclor has been stored in a test cup in the laboratory for four weeks at 100°C with no deterioration of the lining being noticeable. More compatability data for Aroclor is desired but no problems can be foreseen in this area.

To check the compatability and general aging effect of these drums upon electrical properties, test drums are on order. The steel in the test drums has been washed with naphtha to remove any grease. The steel is not being conditioned with acid and salt. The drums have been lined with the Bradley & Vrooman series 46 epoxy phenolic lining. They will be filled with good quality Aroclor and allowed to age. Any drop in electrical properties will be measured as a function of resistivity and power factor. After the ageing tests, the drums will be bent up to crack the lining and determine its effect upon the electrical properties.

In conclusion, if foreign competition is to be met, we need a different type shipping container. The phenolic A lined drum, because of the brittleness of the baked phenolic lacquer, does not provide adequate protection. The salt coating on the steel is undesirable when attempting to maintain good electrical properties for Aroclors. The solvent washed epoxy phenolic lined drum appears to be the answer to containing electrical grade Aroclor.

CONCLUSION:

1. The present phenolic A lined drum is not satisfactory for maintaining electrical properties for Aroclors.

2. The phenolic A lining is not flexible enough to provide adequate coverage of the steel.

3. The acid-salt conditioning of the steel is unacceptable.

4. The solvent washed epoxy lined drum shows promise as a material suitable for maintaining electrical properties of Aroclors in drum storage.

5. The additional cost for the epoxy phenolic lining is reasonable for the added protection.

RECOMMENDATIONS:

1. Test solvent washed drums lined with Bradley and Vroomans Series 46 epoxy phenolic lining for compatability and effect upon electrical properties for Aroclors.

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FUTURE:

If solvent wash drums prove acceptable, then the Bradley Vrooman lining series 46 will be recommended as a replacement drum liner.

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DATA:

Data was collected on a 5 gallon phenolic A (ANW4A or Nesco #3) lacquer lined drum. The drum was washed several times prior to filling with the sample. There was a six fold drop in quality in the first wash indicating salt contamination. Each successive wash brought the quality higher. The drum quality listed below was obtained after several washes with laboratory refined material.

Date	Drum Quality		After Liner Was Destroyed		
	R*	PF**	R*	PF**	
2-24-66	4,500	0.05	1,500	0.2	)
					)Lab Treated
2-24-66	5,000	0.04	1,600	0.22	)
2-21-66	1,500	--	350	--	)
					)Plant Material
2-18-66	700	- -	300	- -	)

*R = Resistivity measured at 100°C, 30 sec. charge, 30 sec. read, and reported x 10^9 ohm cm.

PF = Power Factor measured at 1000 cycles.

Note: Considering the conditions for drum lining one would expect a quality drop as the drum liner fails. Since all the data collected correlated with the theory, further testing in the laboratory was unnecessary.

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