

ORGANIC CHEMICALS DIVISION
RESEARCH DEPARTMENT

Project Analysis - Functional Fluids

Project:

Electrical Fluids - Part I - Measurements

Objectives:

1. Develop standard methods for measuring power factor and resistivity.
2. Put these methods into use throughout our company.
3. Publish our methods and promote their use by others.

Justification:

Due to the improved quality of present Aroclor production, available methods for measuring electrical properties of these materials are no longer adequate. Measurements of power factor and resistivity are not reproducible in a given laboratory and even larger variations are found from laboratory to laboratory. It is therefore necessary to improve the methods, adopt them in all Monsanto laboratories and promote their use by others in order to secure adequate control of plant processes, avoid disputes with customers and permit advanced research on dielectric fluids.

Status:

1. Equipment and methods which make possible greatly improved reliability and precision of measurement of power factor and resistivity have been developed. The experimental work is essentially complete.
2. These methods have been discussed with personnel from our Krummrich and Anniston laboratories. They must now secure the necessary equipment and begin to use the new methods. The Krummrich laboratory has started to acquire the new equipment needed. A supply of cells to be distributed to Krummrich, Anniston and Monsanto Mitsubishi was ordered and is now on hand.
3. A paper describing the methods can now be started. It should be finished about October 15.



NEV 028013

741267

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Plans:

<u>Responsibility</u>	<u>Job</u>	<u>Target Date</u>
RHM/RC	Finish method development;	10/15/68
DA/GWM	put into use in our company	2/69
CRC	laboratories, and write paper.	11/1/68

Manpower Assignments:

	<u>Man-Years For 1968</u>	
	<u>T.</u>	<u>NT.</u>
R. H. Munch	.25	
R. C. Cox		.1

Estimated 1968 Costs:

\$ 5,000

Job Nos. Applicable:

1630128

References:

Job No. 4987
Job No. 6638

Sponsor: R. H. Munch

Date: July 18, 1968

NEV 028014

741268

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Project:

Electrical Fluids - Part II - Transformer Fluids

Objectives:

1. Develop capability for measuring high voltage dielectric strength, impulse strength and impulse ratio.
2. Measure these properties for Inerteen, Aroclor 1242 and mineral oil as well as for pressboard impregnated with these.
3. Find sheet insulation which when impregnated with askarel will have better impulse ratio than oil impregnated pressboard. Targets: (a) Promote use of askarel fluids in transformers for higher working voltages; and (b) High temperature transformers, 150°C operating temperature.
4. Follow-up the Acme Electric inquiry about FR insulation for transformers and see if it offers an opportunity for Monsanto.
5. Investigate the usefulness of instruments for determining transformer askarel condition.
6. Assess "all Aroclor" fluid vs. Aroclor blends in transformers. Review with G.E., Westinghouse and Allis Chalmers.

Justification:

Purpose of this work is to expand the use of Inerteen and Pyranol filled transformers. Our present market for these transformer fluids is about \$6,000,000. Successful achievement of our research objectives in this field might expand this market by 25%.

Status:

1. Equipment for measuring A.C. dielectric strength up to 200 KV and impulse strength up to 300 KV is on order and delivery is expected within 2 weeks. Power lines, ground wire and a safety screen have been installed. A dielectric strength test cell for fluids and impregnated pressboard samples has been constructed

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Status: (Continued)

and tested.

A vacuum chamber for impregnating of pressboard and other sheet insulation has been built and is nearly ready to use. Quantities of the fluids and pressboard to be tested are on hand.

2. Measurements will be started as soon as the installation and testing of the equipment is complete, about August 15, 1968.
3. Westinghouse at Sharon, Pa. is working on high temperature transformers using oil and air. They have said that Inerteen (Aroclor blend) filled transformers are at a disadvantage at high voltages >46 KV and at high temperatures, because of low impulse strength and because of incompatible solid insulating materials. We agreed to undertake research work to find a solution to the impulse and high temperature insulating problems with Aroclor. Westinghouse is to explore the possibility of removing insulating restrictions on 27 and 34 KV Inerteen transformers. Westinghouse wants cheaper 15 KV insulation compatible with Inerteen. We have not worked out an approach to the 15 KV problem.
4. Liquid filled transformers are in competition with dry type and more recently with solid encapsulated units. Acme Electric at Cuba, New York, reports a desire to meet overload transformer tests without emission of flame or molten metal. "Normal resins will not pass this test and FR self extinguishing additives must have the flame to release the extinguishing materials". They ask could Monsanto polymerize or solidify Aroclors to use this as basic insulation system?

We should examine the possibility of supplying flame retardant solid or semi-solid insulation to the transformer industry. We have Aroclor and tetrachlorophthalic as raw materials.
6. Isomerizing Aroclor 1238 to 1240 with $AlCl_3$ and distilling will result in fluid with a pour point of $-32^{\circ}C$ to $-27^{\circ}C$. This fluid may extend the operating range of Aroclor 1242 in transformers to include a wider geographic area without resorting to TCB/Aroclor blends.

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Status: (Continued)

The problem is to determine whether the "all Aroclor" is fire resistant enough to be called an "Askarel" and whether it can extend the range of Aroclor 1242 sufficiently to compete with blends. This isomerized Aroclor can compete economically with straight Aroclor 1242 only if we make it by direct chlorination.

G.E. will be assessing Aroclor 1242 vs. TCB/Aroclor blends. We will submit properties of the isomerized Aroclor plus samples if they so desire. If these properties are desired, then work in direct chlorination will be attempted to avoid the costs of an isomerization step.

Plans:

<u>Responsibility</u>	<u>Job</u>	<u>Target Date</u>
RHM/AB	Install and test equipment.	9/1/68
RHM/RC	Measure dielectric strength, impulse strength, calculate impulse ratio for fluids and impregnated pressboard.	12/31/68
RHM/PGB	Present results to Westinghouse.	2/1/69
RHM/PGB Jim Ford	Select new types of sheet insulation for test.	11/1/68
LF/RHM	Test new instruments for determining condition of transformer askarel.	--
JDS/RHM/PB	Provide inputs of new fluids and possible pricing to G.E.'s assessment of Aroclor 1242 as a transformer fluid.	1/15/69
JDS/TSD	Assess problems of chlorinating with $AlCl_3$ at isomerizing temperatures.	12/30/69

Manpower Assignment:

R. H. Munch
R. C. Cox

<u>Man-Years 1968</u>	
<u>T.</u>	<u>NT.</u>
.25	.4

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Manpower Assignment: (Continued)

	<u>Man-Years 1968</u>	
	<u>T.</u>	<u>NT.</u>
J. D. Sullivan	.20	
L. Fowler	.10	
J. Ford (Consultant)		

Estimated 1968 Costs:

\$30,000

Job No. Applicable:

1630228

References:

Job No. 4668
Job No. 6607

Sponsor: R. H. Munch

July 18, 1968

NEV 028018

741272

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Project:

Electrical Fluids - Part III - Capacitor Fluid

Objectives:

1. Maximize compatibility of Aroclor 1242 with polypropylene film in capacitors.
2. Develop methods for purifying epoxy scavengers and used Askarel. Supply sample concentrates to capacitor makers.
3. Discover agents which will promote wetting of polypropylene film, aluminum foil and capacitor paper by Aroclor.
4. Follow developments in metallized paper and metallized plastic capacitors and assess their impact on Aroclor sales, particularly ex U.S.A.
5. See if oxidative degradation of Aroclor might affect its performance in capacitors; develop methods for avoiding such effects.
6. Develop lower viscosity Aroclor capacitor fluid. Meet competitive threat of new fluids - Prodelec 1500 and Clophen LK 8014 for example.
7. Develop a better understanding of factors causing corona discharge in capacitors and seek ways of suppressing it.

Justification:

Our present sales for capacitor fluid is about \$6,000,000. Capacitor manufacturing technology is currently in a state of rapid change due to the advent of epoxy scavengers, polypropylene film and, ex U.S.A., of metallized film. All these developments tend to decrease the amount of fluid required per KVAR. Therefore, we must understand the fluid properties required for capacitors involving these new developments. We must know the fundamental properties of our present fluids and develop means for improving them where possible. Where this is impossible, we must be prepared to supply alternate fluids which do satisfy present needs.

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Status:

1. A method for testing the effect of polypropylene film on the electrical properties of Aroclor 1242 has been developed. It shows that there are striking differences among film samples. Some samples of film degrade the Aroclor so seriously that they should not be used in capacitors. Others degrade it much less and would probably be satisfactory for use up to 100°C. This indicates that the problem can be solved if a suitable grade of film can be secured.
2. Unox 206 has been fractionated on a 5-gallon scale in the laboratory. The purified material yields a 6% concentrate in Aroclor 1242 which has a lower power factor than Prodelec Superad 6% concentrate. This will be used to formulate a quantity of 50% concentrate which will be supplied to customers in Europe to see how well it fills their needs.

Discuss use of Unox 206 with G.E. to determine if we should acquire their know-how in this area. Decide whether or not we should do work on upgrading of used Pyranol II.
3. Samples of materials to be tested as surface active agents to promote wetting of polypropylene aluminum film, foil and paper are being collected. These will be tested by measuring contact angle for Aroclor with and without the additive when placed on the above surfaces.
4. C. R. Coleman has written an excellent report on metallized paper and plastic (Job No. 76001, 70250, June 17, 1968 APL8423 MCL).
5. Laboratory experiments of two kinds have demonstrated that some samples of Aroclor 1242 degrade when exposed to oxygen at temperatures in the vicinity of 100°C. Anti-oxidants to minimize this degradation are being tested. Tests will be made to see if any are effective against oxidative degradation will also improve capacitor life.
6. Samples of Aroclor 1238, 1240 and 1241 have been prepared and isomerized to produce fluids with lower viscosity, pour point and cracking temperatures than regular Aroclor 1242 or Prodelec 1500. Larger quantities of these will be prepared for market tests.

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7. Procure corona measuring equipment. Develop suitable test cell and investigate effect of additives fluid properties, solid insulation and impregnation process on corona levels.

Plans:

<u>Responsibilities</u>	<u>Job</u>	<u>Target Date</u>
RHM/RC	1. Test polypropylene film for effect on Aroclor electrical properties.	10/1/68
RHM/RC/VS/ NM/CRC	2. Fractionate Unox 206, prepare 50% concentrate and market test.	8/1/68 and 1/1/69
VS	3. Develop wetting agents to facilitate impregnation of polypropylene film capacitors.	3/1/69
CRC/PB/RHM/ WRR	4. Follow metallized paper capacitor development. Plan countermeasures.	10/15/68
RHM/RC	5. Determine if antioxidants improve performance of Aroclor 1242.	6/1/69
VS/JDS	6. Define a lower viscosity, pour point cracking temperature fluid and produce 1000 lbs. of electrical quality.	9/68
CRC	7. Seek ways of suppressing corona discharge in capacitors.	9/68
JDS	8. Write Tentative Procedure for the isomerization of Aroclor 1238.	7/30/68
JDS	9. Determine the required conditions for earth treating isomerized Aroclor to insure an electrical grade capacitor fluid.	7/30/68
JDS	10. Obtain 2-55 gallon drums of undegassed Aroclor 1138 from W.G.K.	7/30/68

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Plans: (Continued)

<u>Responsibilities</u>	<u>Job</u>	<u>Target Date</u>
CRC	11. Maintain liaison with ERA on fundamental research on dielectrics.	Continuing
JDS	12. Determine critical physical properties of laboratory isomerized Aroclor 1238 to check out the starting material.	7/30/68
JDS	13. Prepare 100 gallons of isomerized Aroclor 1238 in the Pilot Plant.	9/1/68
JDS	14. Submit samples of isomerized Aroclor 1238 to the sales department for customer evaluation.	9/1/68

Manpower Assignments:

	<u>Man-Years 1968</u>	
	<u>T.</u>	<u>NT.</u>
R. H. Munch	.25	
R. C. Cox		.4
V. Saeger	.5	
C. R. Coleman	.5	
N. Mueller	.5	
J. D. Sullivan	.5	
W. Knapp - Pilot Plant		

Estimated 1968 Costs:

\$45,000

Job No. Applicable:

1630028

References:

Job No. 6668

Sponsor: R. H. Munch

July 18, 1968

NEV 028022

741276

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Project:

Electrical Fluids - Part IV - Cable Fluids

Objectives:

1. Assess the usefulness of purified alkyl benzene by product streams as cable fluids.
2. Explore the desirability of using Aroclors as cable fluids for short industrial voltage A.C. fire resistant power cables.
3. Explore factors affecting the use of Aroclors in D.C. applications.

Justification:

Askarels are presently not used in cables because they are not compatible with present solid cable insulating materials, they are too viscous and too expensive. However, there are some applications both A.C. and D.C. where fire resistant cables would be desirable. We have been told that new techniques have been developed which might overcome the deficiencies of askarels in cables. We must investigate this information and use it to expand the market for our askarel fluids if possible. Alkyl benzenes are known to be more oxidatively stable than mineral oil and to have good dielectric strength. (Monsanto has available certain by-product streams from our alkyl-benzene manufacturing operation.) Therefore, we should assess the value of these as cable fluids.

Status:

1. Use of purified alkyl benzene byproduct material has been explored in a preliminary way. Results were not promising enough to justify pushing this idea at present. The competition is cable oil, a cheap high quality product. Our material probably has better oxidative stability and perhaps slightly better dielectric strength but its price/performance is not enough better than competition to produce real interest.
2. We have received an inquiry from an organization which claims to have patented technology which would permit the manufacture of askarel filled industrial voltage A.C. power cables. We will investigate their claims and cooperate with them in construction of cables for a trial installation if this is warranted.

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Status: (Continued)

3. It is known that askarel type fluids degrade when exposed to D.C. fields. They can be used in D.C. capacitors by adding stabilizers. The mechanism of the degradation is not known. There is interest in high voltage D.C. installations which require cables filled with non-flammable fluid. We should therefore try to determine the mechanism of the degradation by D.C. and seek a remedy for it.

Plans:

<u>Responsibility</u>	<u>Job</u>	<u>Target Date</u>
PGB	1. Follow developments in this area and alert Research to reactivate this project whenever it seems necessary.	Continuing
PGB/RHM WRR	2. Evaluate usefulness of patented technology and decide if it warrants construction of trial cables.	2/1/69
CRC/RHM	3. Study degradation of Aroclor by D.C. electrical fields to determine cause and develop a cure.	8/1/69

Manpower Assignments:

	<u>Man-Years 1968</u>	
	<u>T.</u>	<u>NT.</u>
C. R. Coleman	.2	
R. H. Munch	.05	
R. W. Weiss	.1	

Estimated 1968 Costs:

\$10,000

Job No. Applicable:

1630328

Sponsor: R. H. Munch

July 18, 1968

NEV 028024

741278

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Project:

Electrical Fluids - Part V - New Dielectric Fluids

Objectives:

1. Test and synthesize fluorine compounds related to Aroclors.
2. Determine if nitriles related to the Aroclors are useful dielectrics.

Desired properties:

- a) Less active as solvents for polyolefins
- b) New less soluble polyolefin capacitor film
- c) Lower viscosity, pour point and crack point for capacitors.
- d) Superior resistance to corona.
- e) Lower DK for transformer fluids.
- f) Higher DK for specialty capacitors.

Justification:

In the event that our efforts to improve the properties of our present fluids so that they meet the needs of the polypropylene film capacitor makers fail, we must have alternate fluids to fill their needs. Capacitor makers would like to design capacitors for 120°C hot spot temperatures. New capacitor grade plastic film with the ability to withstand such temperatures in the presence of Aroclor would be needed to achieve this goal. Materials such as poly 4-methyl pentene-1 or crystalline polystyrene if they can be produced in the form of thin, defect free film might be a step in the right direction. In addition, there is a need for fluids for use in low temperature applications, both transformers and capacitors.

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Status and Plans:

Examine fluoro compounds which Monsanto has synthesized, for example at Dayton (MRC) and at Imperial Smelting (Air Force Contract) to see if any have suitable fluid properties. Procure enough samples to test the electrical properties including corona breakdown voltages. Test compatibility of fluids vs. isotactic polyolefin solid dielectric materials. Prepare the fluorochlorobiphenyl derivatives and examine as dielectric fluids.

Manpower Assignments:

	<u>Man-Years 1968</u>	
	<u>T.</u>	<u>NT.</u>
Q. E. Thompson	.1	
R. W. Weiss	.2	
R. H. Munch	.1	
V. W. Saeger	.1	
R. C. Cox		.2

Estimated 1968 Costs:

\$20,000

Job No. Applicable:

1630028

Sponsor: R. H. Munch/Q.E. Thompson

July 18, 1968

NEV 028026

741280

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Project:

Electrical Fluids - Part VI - Air and Water Pollution
Control

Objectives:

1. Follow developments in analytical chemistry leading to more sensitive and specific methods for identifying Aroclors in our environment.
2. Keep in touch with laboratories doing research on environmental contamination by Aroclors including Universities, FDA, USDA, Fish and Wildlife Service.
3. Study present methods for disposal of Aroclors and if necessary develop safer ones.
4. Assess possible toxic effects on humans.

Justification:

During studies of the fate of chlorinated organic insecticides, biochemists have isolated unknown chlorinated hydrocarbons which they have tentatively identified as chlorinated biphenyls. These have been shown to be present in some fish, birds, and wild animals from certain areas at concentrations in the parts per million range. Public health authorities have therefore felt that it was necessary to determine whether or not environmental contamination by chlorinated biphenyls is a hazard to human life or health. It is vital that we cooperate in these studies so that we can be sure that the results are valid and so that we can assess the impact of the findings on the Aroclor business. We may need to cooperate in developing disposal procedures which will not result in harmful contamination in order to avoid restrictive legislation.

Status:

At present, we are collecting all available information on this problem. The Medical Department is following the toxicology and will start a test program at Calandra Labs to determine biological effects of trace Aroclor. Research will evaluate the validity of the published analytical identification. Samples of Aroclors, and in some

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Status: (Continued)

cases of pure chlorinated biphenyl isomers are being made available to government and university laboratories working on this problem for use as calibration standards.

Plans:

<u>Responsibilities</u>	<u>Job</u>	<u>Target Date</u>
REK/ST	Assess validity of analytical methods used by workers in this field.	3/69
WRR/EW/ST	Collect information on all work being done by others in this field.	Continuing
PB/JB/PH	Determine present disposal methods for Aroclors.	3/69
REK/ST Elmer Wheeler	Toxicology - Review with government agencies, Research Institutes. Start outside test program.	8/15/68

Manpower Assignments:

	<u>Total Man-Years 1968</u>	
	<u>T.</u>	<u>NT.</u>
R. E. Keller/Scott Tucker	1.1	
W. R. Richard	.1	
Elmer Wheeler/P. Hodges	.3	
P. Benignus/J. Bryant		

Estimated 1968 Costs:

\$25,000 (Calandra Labs for '68)
\$25,000 (Metabolic Study)

Job No. Applicable

1630328

Sponsors: E. Wheeler/Scott Tucker
P. Benignus/R. H. Munch

July 18, 1968

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