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CYCLOHEXYL DIPHENYL PHOSPHATE

AN UNSUCCESSFUL DEVELOPMENT

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II. SUMMARY AND CONCLUSIONS

1. After evaluation samples had been submitted to American Viscose, E. I. du Pont, and Olin Mathieson for the cellophane application, our toxicity tests revealed an LD_{50} of 2.46 grams per kilo.

2. Based upon this higher toxicity of cyclohexyl diphenyl phosphate (than currently used dicyclohexyl phthalate), all cellophane producers including American Viscose rejected the product.

3. The evaluation of cyclohexyl diphenyl phosphate by the adhesive industry and its consideration for use in other solid-plasticizer applications were negative and were dropped because of:

   A. Its expected premium price

   B. Its nominal performance

   C. Its relatively higher toxicity.

4. Any future candidate for use in cellophane coatings should be no more toxic than dicyclohexyl phthalate or dibutyl phthalate.

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I. INTRODUCTION

During an early development program on solid plasticizers, a sample of cyclohexyl diphenyl phosphate was sent to American Viscose, a manufacturer of cellophane and an authority on plasticizers for cellophane coatings.

In 1955, American Viscose expressed commercial interest in the product and ordered a 100-pound quantity for plant trial tests. From a Pilot Plant preparation, 100 pounds were sold to American Viscose. Simultaneously, thirty-day feeding studies were routinely initiated by us to determine acute toxicity.

Primarily, due to enthusiasm for the plasticizer shown by American Viscose and without benefit of additional application information, a limited development program aimed at the other cellophane manufacturers and a cross section of the industry was activated. This report summarizes the development program and makes recommendations for future action.

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III. RECOMMENDATIONS

1. Development should be wary of initiating an industry-wide program, particulary if appreciable expense is involved, when the incentive for such a program is based on the interest of only one customer.

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IV. DISCUSSION

A. History of Development Program

Approximately eight years ago, a small sample of cyclohexyl diphenyl phosphate was submitted to American Viscose for their evaluation in nitrocellulose coatings of moisture-proof, heat-sealable cellophane. In mid-1955, they requested and received an additional two pounds.

Following this, they requested 100 - 200 pounds of the product for a plant trial and indicated an ultimate potential of 300 - 500,000 pounds/year. From a Pilot Plant preparation, 100 pounds were sold to them in early 1956.

Because of the American Viscose interest, and in order to broaden potential sales of this phosphate, it was recommended for evaluation to the other cellophane accounts, Olin-Mathieson and du Pont.

Shortly after the shipment to American Viscose, our standard 30-day feeding studies were requested from our Medical Department. The results indicated an order of toxicity considerably higher than dicyclohexyl phthalate, a product commercially used in this application. The LD_{50} for cyclohexyl diphenyl phosphate was 2.46 grams per kilo. Rats survived a dosage of 15 grams of dicyclohexyl phthalate per kilo. During subsequent conversations with the customers, Development learned that they would not use a plasticizer more toxic than dicyclohexyl phthalate. This information was obtained concurrent with our cyclohexyl diphenyl phosphate program while trying to establish Monsanto as a supplier of dicyclohexyl phthalate. Work on the latter product gave us our first close contact with this industry.

Though cyclohexyl diphenyl phosphate had shown merit in cellophane coatings, when the toxicity summary was received, each account lost interest in the product, citing toxicity as the reason.

In addition to our program with the cellophane producers, cyclohexyl diphenyl phosphate was suggested as a premium solid plasticizer (50-55¢/lb.) for polyvinyl acetate adhesives. Though samples were sent to 35 interested accounts, no commercial desire for the product developed during the two-year program.

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B. Physical Properties

Acidity	0.02 meq. /100 grams
Color of Melt	APHA 30
Melting Point, °C.	39 - 40
Moisture	0.05%
Refractive Index at 25°C.	1.5345
Specific Gravity at 25/25°C.	1.1802

C. Resin Compatibility

Cyclohexyl diphenyl phosphate is compatible in the following resins:

Cellulose Acetate
Ethyl Cellulose
Nitrocellulose
Polyvinyl Acetate
Polyvinyl Chloride

D. Toxicity Data

Oral Toxicity in Rats (data supplied by the Monsanto Medical Department)

Cyclohexyl diphenyl phosphate in a corn oil solution was fed to rats with the following results: The Oral LD_{50} was 2.46 grams/kilogram with a survival time of overnight to three days. All the animals that received lethal doses but survived overnight, showed various degrees of paralysis. Some of those not succumbing developed partial paralysis of at least a semi-permanent nature. Thirty days after being dosed, they moved with a halting gait, had jerky head movements and exhibited a curling effect when lifted by the tail. Autopsy showed moderate liver and lung hyperemia when observed microscopically.

Oral Toxicity in Rabbits

The minimum lethal dose in rabbits was 7.5 to 10.0 grams/kilogram. Survival time was 6 - 14 days. Some of the animals at higher feeding levels developed diarrhea, lethargy, and loss of appetite, but no definite paralytic symptoms were observed. Autopsy showed liver disfunction and damage. The kidneys were moderately congested.

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