VC Bernt, testing of PVC Films

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Testing of PVC Films

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Title: Testing of PVC Films Produced by the Electrochemical Combination at Bitterfield with Regard to Their Toxicity

(The title VED is in East German equivalent of corporation--translates literally as "people's own business.")

The article is by Bernt done at the Surgical Hospital at Lennon Street, in Karl Marx City, East Germany.

Development of plastic and its multitudinous application raise problems with regard to its possible toxicity and have been proven not harmful. (Lehmann) But as to some of them it cannot be said with certainty that they present absolutely no danger to the human body.

The most used polyvinyl chloride today is employed in the manufacture of various consumer articles. For example, floor coverings, packaging material, raincoats, tubes, blood transfusion apparatus, sponges, etc.

In the production of polyvinyl chloride mostly organic tin compounds are used as stabilizers. Little is known about the toxicity of tin as yet. Researchers have found workers who have breathed tin vapors for years. They have found the metal in their lungs, liver, lymph nodes, and spleen, without any indication of poisonous results. Certain tin salts behave differently. For example, tin chloride causes nerve damage. More recent research has shown that the relative harmlessness of tin rests solely upon the fact that it is difficult to ingest tin into the body in soluable form. The toxicity shows itself most strongly through the use of alkaline derivatives. Stonerbarnes, Janet and Duff (footnote 7) have established that dialkyl tin combinations and trialkyl tin combinations behave differently. Trialkyl tin combinations are significantly more toxic. The effect is primarily on the nerve system. It can cause paralysis, test animals lose weight and die. Accumulation of tin can be shown above all in the spleen, which in many cases has lead to a change in its outer appearance. According to Zeller (see the reference to Oettel in footnotes 5 and 6) tin combinations of the type of tributyl tin can cause strong skin discoloration. Tin stabilizers with long fatty acid chains prove themselves to be the least toxic.

In the Electrochemical factory at Bitterfield, dibutyl tin dichloride is used to stabilize PVC. The end product contains 1.5% of the stabilizer. In the production a fatty acid ester of dibutyl tin is used. Dibutyl tin chloride is first formed during the polymerization of the PVC.

The fatty acid ester and also the dibutyl tin chloride are soluable in almost all organic solvents. Toxicity of the preparation has been tested by Stoner and his co-workers (see footnote 7) in animal tests. While no lethal doses for rabbits and hamsters has been established, for rats it is 100 milligrams for each kilogram of bodyweight by peroral administration.

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In contrast to tributyl tin, the toxicity is 100% lower.

Since obtaining the raw materials for the production of tin stabilizers is difficult in the German Democratic Republic, people have attempted to replace tin with lead combinations for use as stabilizers. The PVC produced with these stabilizers differed from that produced with tin stabilizers. This is evidenced by a darker or merky appearance. It is, however, from a technical point of view, fully identical. In contrast to tin, the toxicity of lead has been known for a long time. It is therefore necessary to speak about the evidences of poisoning somewhat more thoroughly. Although the poisonings result mostly from lead vapor, poisonings can also occur after a lengthly absorption of the material in the stomach and digestive tract. The toxic dose has been stated at different levels. It jumps from between 1 and 10 milligrams per day from month long to year long consumption (in humans). Lead is accumulated in the human body from 95 to 97% in the skeleton system, the rest is in the inner organs--above all in the cerebellum. The use of PVC for the production of consumer articles assumes that PVC, even in cases of large ingestion in the human body, will behave completely indifferently. Since in the articles available to us stabilizers with both tin and lead compounds are contained, it must be shown that these metals, the toxicity of which can be taken as shown, come into the body not at all or only in minute doses and that poisonings can be excluded. For testing there are two possibilities:

(1) proof of whether plastic can be dissolved in body fluids and taken up by the body; and

(2) proof of toxic occurrences in animal tests.

Electrochemical Combination at Bitterfield made available the following plastics to us:

(1) SPVC-stabilizer polymer with 1.5% with stabilizers PP (lead salt of a paraphin carbon acid);

(2) SPVC-stabilized polymer with 1.5% stabilizer PT (powder past 80-20 AH compound); and

(3) SPVC-stabilizer polymer with 1.5% of the stabilizer OZS powder past 80-20 AH (dibutyl tin dichloride).

We attempted to establish to what degree the tested plastics are soluable in the digestive juices of the human body. We used human stomach and duodenal fluids. The types of PVC were placed in the fluids. After a period of 24 hours at 37° celcius the determination of the various extracts in the stomach fluids was done using the Windisch table. In the duodenal fluids the determination was done by distillation of the extract. The results are shown in Table 1. To read Table 1 the words "duodenal" "duodenalsaft" is "doudenal fluid" and "magensaft" is "stomach fluid--gastric juices."

Even if only small amounts are provable, it has however been shown, that the absorption in the organism can occur. This is greater in the duodenal fluids as compared to the stomach fluids. The tin stabilizers are more easily dissolved than the lead stabilizer. Although the substance which went into solution contained various parts of plastic, it is to be assumed, that the main part was the stabilizer and the softening agent. Due to the minimal amount of the dissolved stabilizer, it is hardly to be assumed, however, even in spite of lengthly ingestion of plastic, that any toxic results will occur.

The tests on animals was done on rabbits. There were two series--in the first, plastic was put in two stages in the muscle of the upper thigh and in the other case the animals were fed three times a week for 16 months with a suspended pulverized plastic. Each testing encompassed four animals for each preparation, of which two were fed and two were implanted. The implantation was done in quantities of 5 grams in powder form in the muscle of the upper thigh. Table 2 shows how many grams per kilograms of bodyweight each animal received.

Powder form was chosen because it is assumed that thereby the largest possible absorption surface would be achieved.

Next table shows the left hand column--the average weight of the animal at the time of implantation, right hand column--the amount implanted in grams for each kilogram of bodyweight. [Now on page 348 of articles.] The plastic behaved completely without irritation. The animals developed normally in comparison with test animals. The bodyweight curve showed a constantly climbing line. The feeding was done as with the other animals with a mixed feed dependent on the season. There were no indications whatever of poisoning. Upon autopsy, the plastic could no longer be found in the tissue. There apparently was a complete absorption of the material. (This sentence apparently concludes with some comment on scar tissue at the place where the plastic was implanted.)

A microscopic examination on the tissue on all organs showed no effect. In accordance with earlier experience that an accumulation of lead occurs mainly in skeletal system and with regard to the inner organs, mostly in the cerebellum, we attempted to find lead in bones and the brain. It has not been established in which organ tin is likely to accumulate, so we sought evidence of it in the liver, brain, and in the bones. Tables 3 and 4 give an overview of the values that were found. Although they are very low, they indeed show that an absorption of the stabilizers from the plastic can occur. (Table 3 is titled evidence of lead in the implanted animals; first column on the left is in the bones, second column is in the brain, and the third column is an abbreviation which I cannot translate.) (Table 4 shows evidence of tin in the implanted animals. All values are given in milligrams per percent of the material tested. There are five columns: bones, brain, liver, kidneys and again the same title which is given above in Table 3, third column, which I believe is the amount which was absorbed or examined totally.

We have in addition attempted to locate lead and tin in the serum in the animal. The values found here lie far below those values given as toxic concentrations for humans. (.04 milligrams per percent). In order to show a lead intoxication, blood pictures were prepared which showed no deviation from the normal, particularly no [vasophile?] spotting could be shown. In addition, the examinations could exclude the possibility of a porphyrinurie. The animals were fed with pulverized suspended plastic. At first a 5% and later a 10% suspension was used. The 10% suspension was prepared with some sort of duodenal fluid. The test conditions were equivalent to those animals which were implanted. Table 5 shows the amount fed each animal by kilogram of bodyweight.

Also here there were absolutely no appearances of intoxication which could be shown. The animals developed completely normally, the bodyweight curve climbed continuously.

The next paragraph deals generally with the condition of animal no. 3 which apparently died of natural causes.

Tables 6 and 7 show the equivalent of concentrations of tin and lead in the organs. Whereas in the implanted animals no lead was found in the bones, now small amounts of lead are present. Only in the case of animal no. 3 which died during the test the values are somewhat higher. The animal was fed with the same amounts as the others but had constantly had a lower bodyweight, one must assume that it was for this reason that a higher concentration resulted in his body. Its death cannot, however, be directly connected with the test since no appearance of the lead poisoning could be established. Also in the case of the animals fed, blood tests were done for [vasophile?] spotting and testing of the serum for lead and tin. In the latter case the amount was far below the established toxic concentration. In the blood pictures a porphyrinurie could not be established. The plastic concentrations varied somewhat as shown by Tables 2 through 5.

The tests show that in cases of PVC with lead and tin stabilizers probably there will be some absorption of the stabilizers. The administered quantities, particularly in the case of feeding, are very high. If computed for humans it would mean, that, in order to achieve the same accumulation, the quantity on the average of 2,800 grams would have to be taken up by the body in a year. It is hardly to be assumed, that in the normal use of ordinary articles for human use manufactured of PVC, that an absorption could occur in any amount even approaching our tests.

The second article [which begins "Zum Studium" and appeared in 1966, volume 56 of magazine Kunstoff] deals with thermal decomposition of PVC and different apparatuses to measure HCL emissions or a change in color.

No discussion whatever of toxic matters or of ingestion or breathing by humans is mentioned.

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