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A COMPARATIVE STUDY OF THE TOXICITY OF THE COMBUSTION PRODUCTS OF TEDLAR AND A FLUORENONE-POLYESTER FILM

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INTRODUCTION

The relative toxicity in the rat resulting from a 30-minute exposure to the combustion products of two materials, Tedlar and a fluorenone-polyester film, has been assessed. The combustion products were generated into a static exposure system using a laboratory-scale furnace. The toxicity was assessed using the primary measurements employed in a more detailed overall toxicity evaluation. The endpoints employed in the assessment were incapacitation and death. The toxicological events observed during the 30-minute exposure are reported here. This report does not consider any post-exposure consequences of the exposure.

METHODS

Combustion of Materials

The sample sizes used in this study were chosen to produce nominal combustion product concentrations ranging from 5 to 40 grams per cubic meter. These concentrations were the quotient of the number of grams of sample introduced into the furnace divided by the chamber capacity (.064 m^3).

Exposure System

The exposure chamber used for these studies was of an octagonal configuration with a nominal volume of 60 ℓ. A circular port was present on each of four faces of the chamber, approximately 6" above the floor. Into these ports were inserted four male pigmented Long-Evans rats (350-450 gm) held in tubular restrainters, so that they could be exposed to the combustion atmosphere in a head-only fashion. The furnace and combustion conditions used in the study were those reported by Potts and

Lederer (1977). The materials were combusted in both the flaming and nonflaming modes. The furnace was mounted below the chamber such that the mouth of the furnace was essentially flush with the bottom of the chamber. The furnace held a Monel beaker in which the sample was combusted. A PTFE-coated cone was placed above the furnace to shield the animals from direct flame radiation, and to aid in convection of the combustion products.

Toxicological Evaluation

Rats were exposed to the combustion atmospheres for a period of 30 minutes. To determine incapacitation, all animals were monitored for performance of the leg-flexion avoidance response, using a method similar to that described by Packham *et al.* (1978).

Analysis of the combustion product atmosphere was carried out throughout each exposure. Combustion atmospheres were sampled at 3.5-minute intervals for CO, CO_2, and O_2, which were detected using gas chromatographic techniques. Temperatures inside the chamber were monitored utilizing a chromel-alumel thermocouple at the level of the animals, with an external reference cold junction and recorded on a strip chart recorder.

The ability of each material to generate CO under the conditions of the experiment was expressed as the CO-generating capacity (mg CO/gm material). This was calculated for each exposure using the following equation:

$$\text{CO-generating capacity (mg CO/gm material)} = \frac{\text{ppm} \times \text{chamber vol. } (\ell) \times \text{M.W.} \times 10^{-3}}{\text{sample wt.} \times 25.79^{*}}$$

*mole volume in Salt Lake City

The relationship between the percentage of population affected versus concentration of combustion products (gm/m^3 of material introduced into the furnace) was established employing the statistical methodology described by Miller and Tainter (1944). This relationship was obtained for both incapacitation and death. The EC_{50} (concentration causing incapacitation in 50% of the population) and LC_{50} (concentration causing death in 50% of the population) were calculated for each material, under the two combustion conditions.

Animals surviving the exposure were subjected to a behavioral examination immediately post-exposure. This examination considered standard observations designed to determine their behavioral, motor coordination, central nervous system and autonomic capabilities. Blood samples were obtained by cardiac puncture from those animals that died during the exposure, and carboxyhemoglobin (COHb) levels were determined using an Instrumentation Laboratories 282 Co-Oximeter.

Animals surviving the exposure were retained for 14 days. During this post-exposure period they were weighed on a regular basis and any deaths occurring were recorded. Observations that were made during this period will be presented in an addendum to this report. This will include a re-calculation of the respective LC_{50} values based upon the total number of deaths observed both during the 30-minute exposure and the 14-day post-exposure period.

Materials

Both materials, Tedlar and the fluorenone-polyester film, were supplied by NASA-Ames Laboratory. Both materials were supplied as thin films. The Tedlar sample was opaque, and the fluorenone-polyester film was clear.

TABLE 1

THE INCAPACITATING AND LETHAL POTENCIES OF THE NONFLAMING AND FLAMING COMBUSTION PRODUCTS OF TEDLAR AND A FLUORENONE-POLYESTER FILM

Combustion Condition	Material	Furnace Temperature (°C)	CO Generation mg/gm	Incapacitation EC_{50} ± S.E.	Death (30 min.) LC_{50} ± S.E.
Nonflaming	Tedlar	700	101	18.8 ± 6.8	34.0*
	Fluorenone-polyester	720	240	10.9*	17.2
Flaming	Tedlar	800	47	21.0 ± 6.8	> 40
	Fluorenone-polyester	780	227	10.7 ± 0.8	13.2 ± 1.4

*insufficient data to calculate standard error (S.E.)

Carbon Monoxide Levels

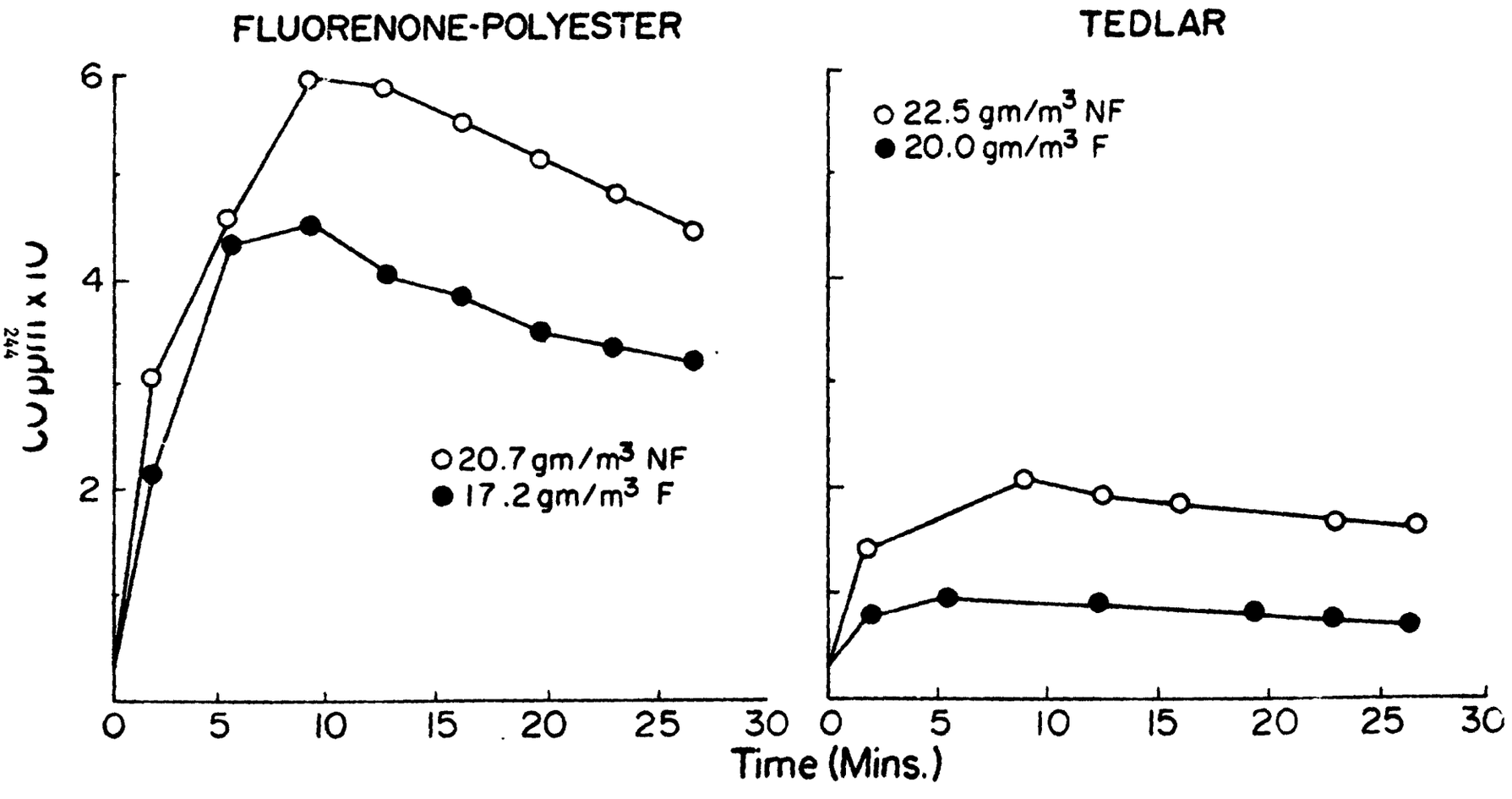


TABLE 5a

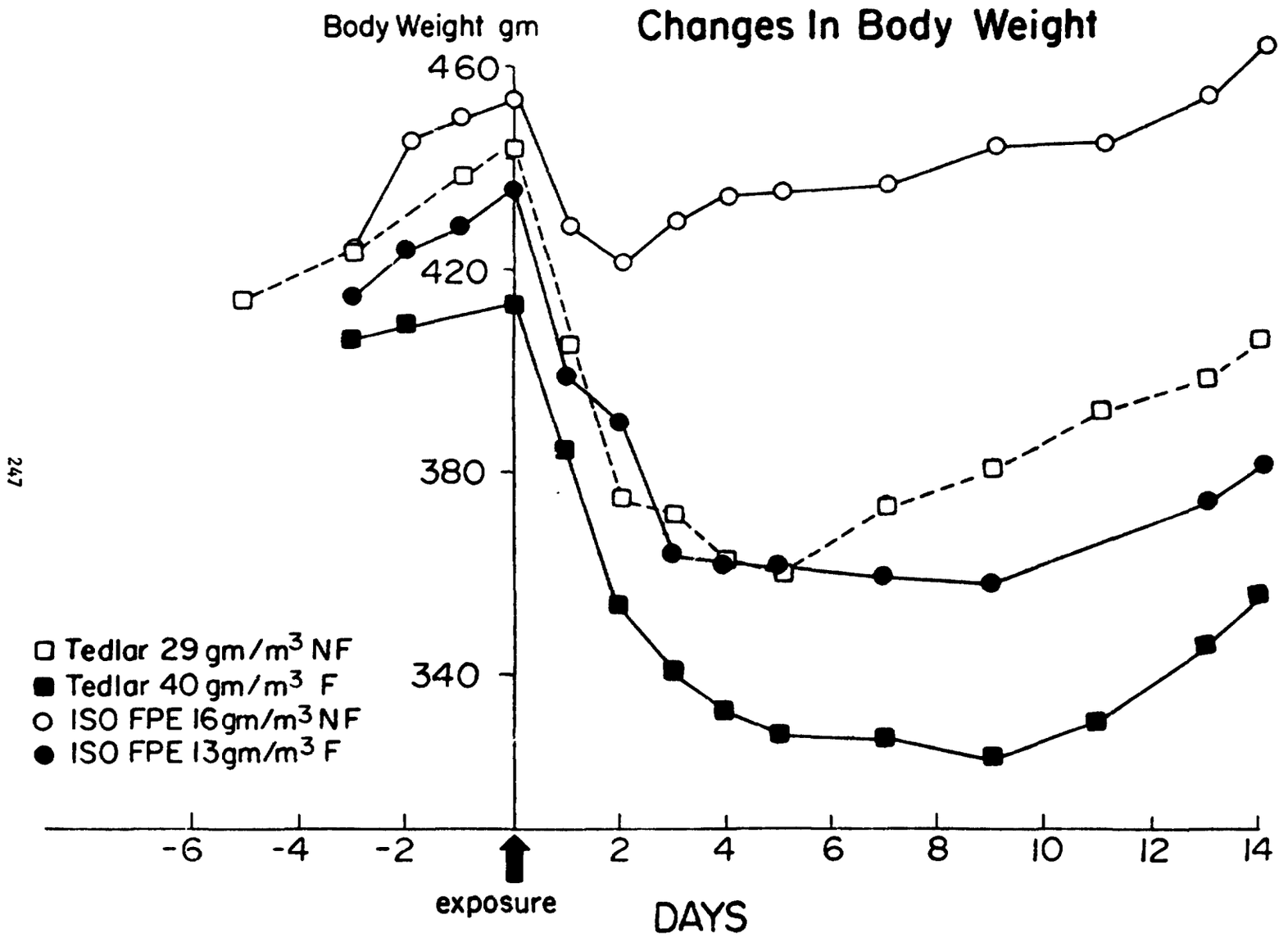
COMPARISON OF TOXICOLOGICAL OBSERVATIONS ON SURVIVING RATS EXPOSED TO THE NON-FLAMING COMBUSTION PRODUCTS OF A POLYESTER FILM AND POLYVINYL FLUORIDE FILM (PVF)

		Number of animal showing observation						
		Polyester film			PVF film			
Concentration gm/m^3		10.3	11.6	16.2	5.0	7.9	22.5	29.3
Observations								
Incapacitation		0	4	4	0	0	1	4
(mean time - secs.)		(-)	(1139)	(963)	-	-	(1735)	(701)
Behavior	n=	4	4	4	4	4	4	4
↓ activity		1	0	4	0	0	4	4
↓ sensitivity to touch		0	0	0	0	0	0	0
↓ pain (tail pinch)		0	0	3	0	0	0	3
↓ nuzzle response		1	1	4	0	0	0	0
Motor Coordination								
↓ righting reflex		2	3	3	0	1	2	4
↓ hang response		0	4	3	0	0	2	3
↓ posture		1	3	4	0	0	4	2
↓ muscle tone		4	4	4	0	0	4	3

TABLE 5b

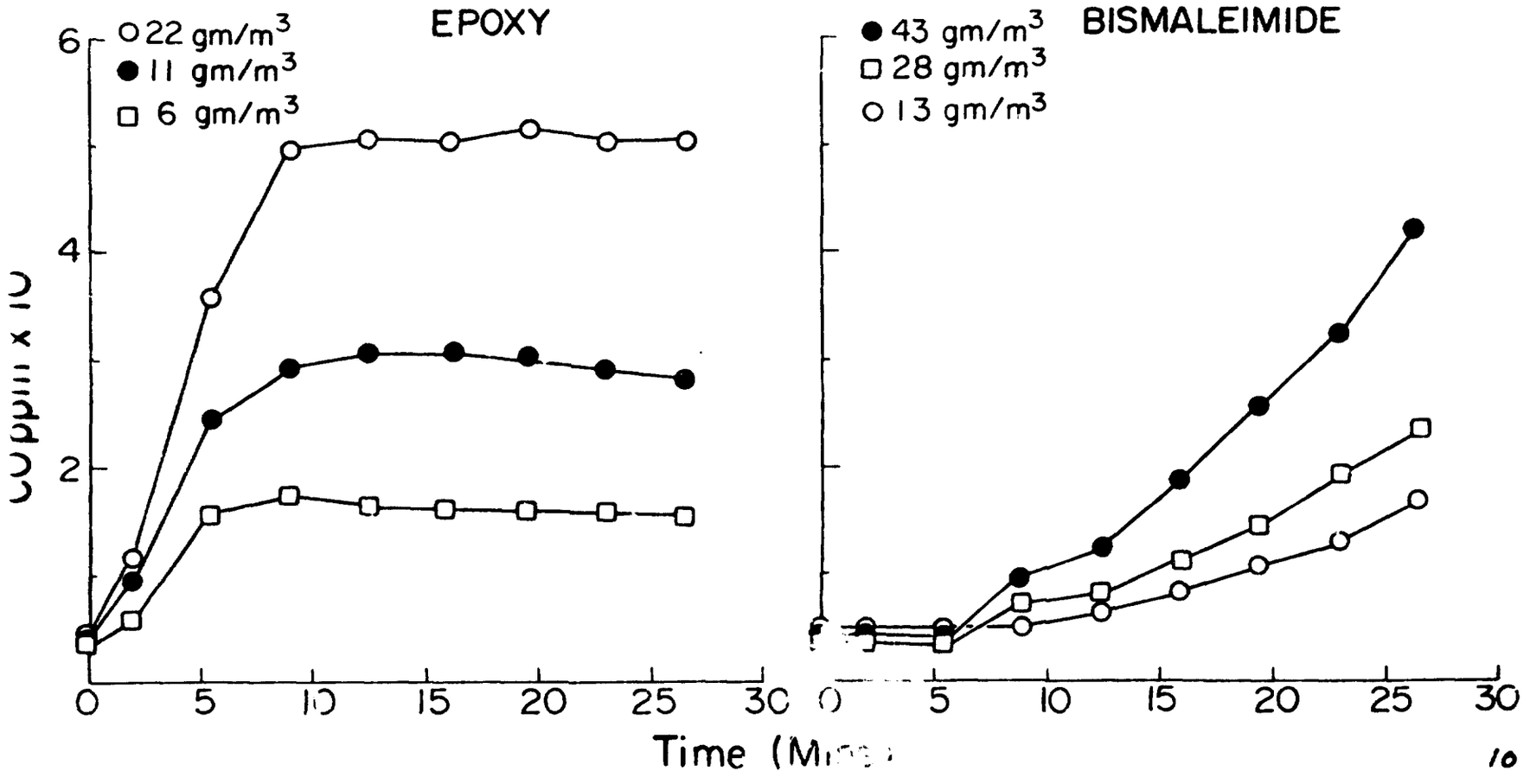
COMPARISON OF TOXICOLOGICAL OBSERVATIONS ON SURVIVING RATS EXPOSED TO THE NON-FLAMING COMBUSTION PRODUCTS OF A POLYESTER FILM AND POLYVINYL FLUORIDE FILM (PVF)

	Number of animals showing observation						
	Polyester film			PVF film			
Concentration gm/m^3	10.3	11.6	16.2	5.0	7.9	22.5	29.3
CNS							
+ startle response	0	0	0	0	0	1	3
tremors, twitches, convulsions	0	0	0	0	0	0	0
Autonomic							
eyes - + corneal reflex	0	0	0	0	0	0	0
+ lachrymation	3	0	2	2	4	4	4
+ clarity	0	0	3	0	0	4	4
salivation	0	1	1	1	4	2	3
nasal discharge	1	1	0	0	4	4	3
visible respiration - abnormal	4	1	4	0	2	2	4


Changes In Body Weight
Body Weight gm
460
420
380
340
□ Tedlar 29 gm/m³ NF
■ Tedlar 40 gm/m³ F
○ ISO FPE 16gm/m³ NF
● ISO FPE 13gm/m³ F
-6
-4
-2
exposure
2
4
6
8
10
12
14
DAYS

Material	Combustion Condition	Furnace Temperature	CO generated mg/gm	HCN generated mg/gm	EC_{50} ± S.E.	LC_{50} ± S.E.
EPOXY	NF	600°C	74.6 ± 10.7 n=8	3.2 ± 0.7 n=10	4.14 ± 0.87	11.01 ± 2.09
	F	680°C	50.5 ± 13.1 n=8	2.5 ± 0.6 n=8	6.23 ± 1.04	7.26
BISMALEIMIDE	NF	490°C	27.5 ± 5.2 n=9	1.4 ± 0.3 n=9	20.13 ± 3.88	41.85 ± 3.16
	F	700°C	85.6 ± 8.7 n=10	2.9 ± 0.9 n=10	6.83 ± 1.45	14.98 ± 2.22

Carbon Monoxide Generation From Non-Flaming Combustion of Resins



Hyrodogen Cyanide Generation From Non-Flaming Combustion of Resins