

FIRE TOXICOLOGY PROGRAM: JSC METHODOLOGY

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Toxicological testing of spacecraft materials was initiated at the Johnson Space Center in 1965. Toxicological evaluations of the pyrolysis/combustion products of candidate spacecraft materials were performed using a modified 142 liter Bethlehem Chamber equipped with a Lindberg Model 55031 furnace external to the chamber. In all of the toxicological assessments lethality was chosen as the endpoint. A new pyrolysis/combustion chamber with an internal furnace has been developed for toxicological testing and ranking of both spacecraft and aircraft materials. The pyrolysis/combustion chamber has a relatively small volume (75 liters) and permits the use of both behavioral and physiological measurements as indicators of incapacitation. Methods have been developed which employ high resolution gas chromatography/mass spectrometry to generate chamber atmospheric profiles which indicate the reproducibility of pyrolysate concentrations. The atmospheric volatile profiles in combination with CO, CO₂ and O₂ analysis indicates that a small chamber equipped with an internal furnace will give reproducible results.

The data presented is generated from a chamber designed from guidelines set forth by The National Research Council's Committee on Fire Toxicology.

JSC METHODOLOGY (CONT'D)

- o CAGE TYPES WITHIN CHAMBER
 - o BEHAVIORAL CAGES INTERFACED WITH COMPUTER
 - o PHYSIOLOGICAL CAGES INTERFACED WITH APPROPRIATE INSTRUMENTATION (EKG, RESPIRATION, ETC.)
 - o OBSERVATIONAL CAGE (NO MEASUREMENTS RECORDED BY INSTRUMENTS). SUBJECTS USED FOR HISTOPATHOLOGY STUDIES AND FOR LETHALITY
 - o ALL CAGES LOCATED EQUAL DISTANCE FROM PYROLYSIS/ COMBUSTION SITE

- o SUPPORTING INSTRUMENTATION
 - o GAS CHROMATOGRAPHS
CO, CO₂, O₂, NO_x, SO_x AND ORGANIC VOLATILES
 - o GAS CHROMATOGRAPH/MASS SPECTROMETER IDENTIFICATION OF ORGANIC VOLATILES
 - o CO-OXIMETER
CARBOXYHEMOGLOBIN IN BLOOD
 - o SCAT - PDP8/E SYSTEM
MEASUREMENT OF BEHAVIORAL INCAPACITATION
 - o INORGANIC GASES (WET CHEMISTRY

JSC METHODOLOGY

- o PYROLYSIS/COMBUSTION
 - o CHAMBER RELATIVELY SMALL IN SIZE (75 LITERS)
 - o ALLOWS SMALL SAMPLE
 - o ACCESSIBLE FOR CLEANING
 - o ALLOWS RELIABLE OBSERVATIONS
 - o LESS GAS STRATIFICATION
 - o CHAMBER SIDES CONSTRUCTED OF PLEXIGLASS
 - o RELATIVELY INERT TO SAMPLE
 - o ALLOWS EXCELLENT VISUAL OBSERVATION
 - o FURNACE IS CONDUCTIVE TYPE
 - o FURNACE IS LOCATED INSIDE CHAMBER
 - o TEMPERATURE RANGE TO 1000^o C
 - o CAPABLE OF INTRODUCING O₂ OR N₂ AT PYROLYSIS/COMBUSTION SITE
 - o EXCELLENT TEMPERATURE STABILITY

Figure 1.

Gas Chromatographic Mass Spectrometric profile of Linear Polyethylene pyrolyzed at 600°C as sampled by a grab sample from the JSC pyrolysis/combustion chamber.

0.2724g LINEAR POLYETHYLENE (600°C)

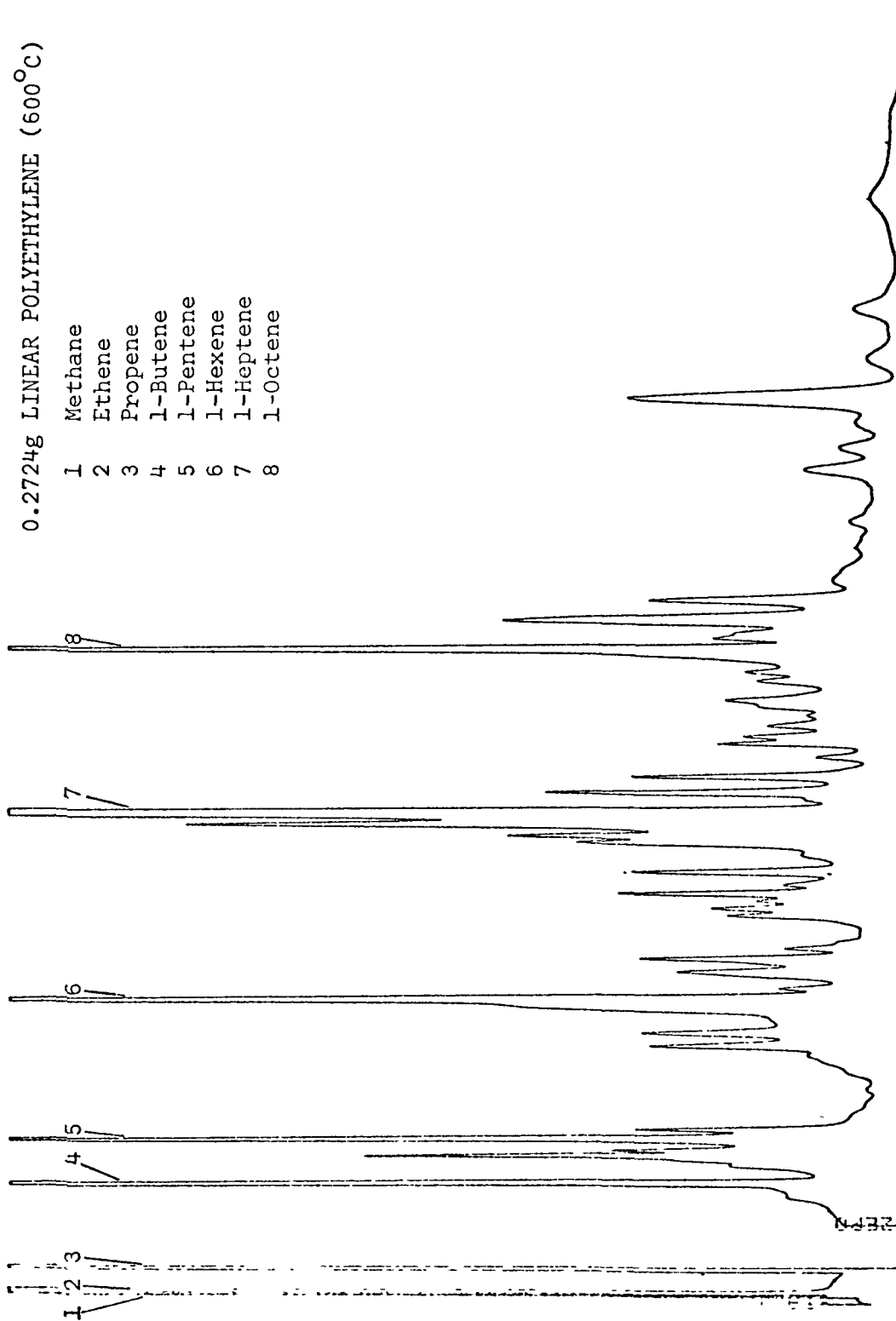


Fig. 1

Figure 2.

Three different gas chromatographic profiles of linear polyethylene pyrolyzed at 600°C. All samples were collected by the grab method to avoid moving the chamber atmosphere through an online instrument. The profiles are essentially identical for three different burns using the same number of test animals and weight of materials.

LINEAR POLYETHYLENE

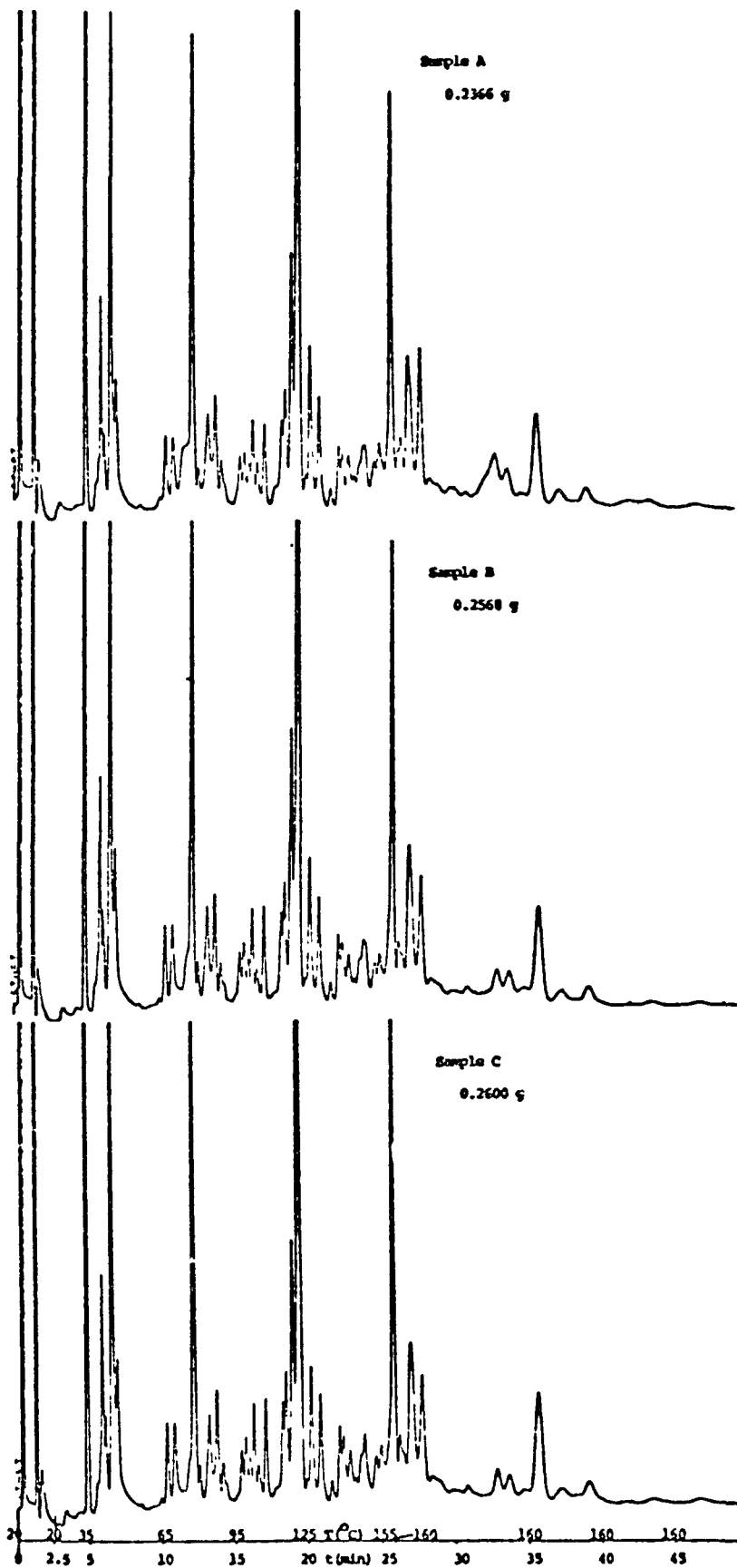


Fig. 2

Figure 3.

Oxygen, carbon monoxide and carbon dioxide data for linear polyethylene pyrolysis at 600⁰ C. The data is representative of multiple runs at each quantity of material.

OXYGEN, CARBON MONOXIDE AND CARBON DIOXIDE DATA
FOR LINEAR POLYETHYLENE PYROLYSIS AT 600°C

<u>t(min)</u>	<u>0.2707g Sample</u>			<u>0.7417g Sample</u>		
	<u>% O₂</u>	<u>ppm CO/g</u>	<u>% CO₂</u>	<u>% O₂</u>	<u>ppm CO/g</u>	<u>% CO₂</u>
0			0.11			0.10
5		801	0.28		926	0.38
10			0.47			0.52
15		838	0.62		921	0.69
20			0.70			0.80
25			0.87			0.96
30	19.59	823	1.04	19.76	934	1.08

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Fig. 3