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THERMAL CONDUCTIVITY OF RDX

B. D. Faubion

DEVELOPMENT DIVISION

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For
Sandia Laboratories
Albuquerque, New Mexico

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ABSTRACT

The thermal conductivity of RDX was determined at 222, 293, 347, 394 and 450 K. The thermal diffusivity of pellets pressed to four different densities was measured using the pulse heating method. The specific heat was measured at each temperature using the DSC method. The thermal conductivity was calculated from the thermal diffusivity, density and specific heat.

INTRODUCTION

The pulsed method for measuring thermal diffusivity is well documented (1,2,3,4,5). An adaptation of this technique has been used to measure the thermal diffusivity of the explosive hexanitrostilbene (HNS) as a function of temperature(6).

EXPERIMENTAL PROCEDURE

Details of the apparatus and experimental procedure have been given previously(6). A cutaway of the test chamber and a block diagram of the setup is shown in Fig. 1.

The specific heat was determined using the standard procedure for the Perkin-Elmer Differential Scanning Calorimeter Model DSC-I(?).

The RDX (Ensign Bickford Lot ENB-01-01) was pressed in a 1.27 cm diameter die on the Dead Weight Press to four different densities. The pellets were approximately 0.13 cm thick so that edge loss effects were insignificant.

RESULTS AND DISCUSSION

The specific heat of RDX at five temperatures is listed in Table I. The values are the average of two runs which were within $\pm 2\%$ of the average. A plot of the specific heat as a function of absolute temperature is shown in Fig. 2.

The thermal diffusivity for the four densities at each temperature is listed in Table II. The thermal diffusivity was determined by analysis of the temperature-time plots of the rear surface temperature. The diffusivity was corrected for finite pulse time and heat-loss effects using Heckman's tables(8).

The thermal conductivity was calculated using the corrected thermal diffusivity, the density and the specific heat at each temperature. The results are tabulated in Table III. Each value is the average of three runs and the sigma ranges from approximately $\pm 3\%$ near room temperature to $\pm 10\%$ at the two temperature extremes. The results are graphically illustrated in Fig. 3. There is no consistent trend for the thermal conductivity of the various density pellets at each temperature. If the average thermal conductivity at each temperature is plotted a smooth

curve can be drawn. This curve shows a minimum at approximately 273 K (0 C). This may be related to the presence of moisture which would result in the formation of frost. The thermal conductivity of ice increases with decreasing temperature and is 30 to 50 times greater than the values being measured; therefore, the increase in thermal conductivity from 293 K to 222 K could be accounted for by as little as 0.15% ice.

The average value of the thermal conductivity at 450 K is 2.3×10^{-4} cal cm⁻¹ sec⁻¹ deg⁻¹ for an average density of 1.575 g cm⁻³. This value is in fair agreement with the value given by Rogers(9) of 2.53×10^{-4} cal cm⁻¹ sec⁻¹ deg⁻¹ for a density of 1.533 g cm⁻³.

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Fig. 1. Test Chamber and Block Diagram of Thermal Diffusivity Apparatus

Table I. Specific Heat of RDX

<u>T (K)</u>	<u>C (cal g⁻¹ deg⁻¹)</u>
222	0.207
293	0.239
347	0.265
394	0.313
450	0.351

Table II. Thermal Diffusivity of RDX (ENB-01-01)

<u>Temp.</u> <u>(K)</u>	ℓ (cm): ρ (g cm ⁻³):	<u>($\lambda \times 10^4$) cm² sec⁻¹</u>			
		<u>0.1341</u>	<u>0.1372</u>	<u>0.1252</u>	<u>0.1397</u>
		<u>1.6604</u>	<u>1.6347</u>	<u>1.5701</u>	<u>1.4350</u>
222		4.50	6.27	3.72	6.62
293		4.41	5.04	4.02	3.97
347		3.14	3.96	5.43	4.27
394		4.03	3.66	5.21	3.86
450		3.83	3.84	5.00	3.98

Table III. Thermal Conductivity of RDX (ENB-01-01)

<u>Temp.</u> <u>(K)</u>	ℓ (cm): ρ (g cm ⁻³):	<u>($\lambda \times 10^4$) cal cm⁻¹ sec⁻¹ deg⁻¹</u>			
		<u>0.1341</u>	<u>0.1372</u>	<u>0.1252</u>	<u>0.1397</u>
		<u>1.6604</u>	<u>1.6347</u>	<u>1.5701</u>	<u>1.4350</u>
222		1.55	2.12	1.21	1.97
293		1.75	1.98	1.51	1.36
347		1.38	1.71	2.26	1.62
394		2.09	2.07	2.56	1.74
450		2.24	2.20	2.76	2.00

Fig. 2. Specific Heat of RDX as a Function of Absolute Temperature

	ℓ cm	ρ g cm ⁻³
○	0.13716	1.6347
□	0.1252	1.5701
●	0.134112	1.6604
▲	0.1397	1.435

Fig. 3. Thermal Conductivity of RDX

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