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by

Charles L. Mader

William J. Carter

AN EQUATION OF STATE FOR SHOCKED POLYURETHANE FOAM

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ABSTRACT

The experimentally observed behavior of systems of high explosives, low density (0.5- and 0.3-g/cc) polyurethane foam, and metals can be numerically reproduced if the foam is assumed to decompose and the decomposition products are described by a BKW equation of state.

INTRODUCTION

The objective of the study described here was to reproduce numerically the experimentally observed behavior of systems containing low density polyurethane foams shocked by high explosive to approximately 100 kbar. When the usual high explosive system (such as Composition B) is detonated in contact with 0.5-g/cc polyurethane foam, a shock of approximately 110 kbar is formed in the foam. A linear relationship between shock and particle velocity to describe the experimental Hugoniot data and a constant Grüneisen equation of state to describe state points off the Hugoniot is an adequate equation of state for numerically reproducing the behavior of the first shock through the polyurethane; however, the experimentally observed velocities of the interaction of the shock in the foam with high density materials cannot be obtained with such an equation of state.

We investigated other equations of state for foam which have been suggested in the literature. We could not reproduce the experimental data for multiple- and single-shocked foam without forcing the equation-of-state parameters to have an unrealistic behavior.

Since the foam reaches very high temperatures on the first shock, it seems likely that it becomes a mixture of gaseous and solid decomposition products. The Becker-Kistiakowsky-Wilson (BKW) equation of state, calibrated for carbon-hydrogen-nitrogen-oxygen explosives in the pressure range of interest, was used to calculate the equation of state of polyurethane decomposition products. The BKW Hugoniots for 0.5- and 0.32-g/cc urethane are in reasonable agreement with the experimental data for foams above about 50 kbar. The BKW Hugoniot for bulk-density urethane (1.265-g/cc) does not reproduce the experimental Hugoniot data. This is probably because the high density polyurethane does not reach decomposition temperature until it attains a much higher pressure than that necessary for the low density foam. The urethane BKW isentrope through the single-shock Hugoniot point of interest can be used as an equation of state in numerical hydrodynamic calculations for reproducing the experimentally observed behavior of shocked foam interacting with high density materials.

NOMENCLATURE

I	energy in mbar - cc/g
P	pressure in mbar
U_p	particle velocity in cm/μsec
U_s	shock velocity in cm/μsec
V	volume in cc/g
V_o	initial specific volume
γ	Grüneisen gamma = $(1/V)(\partial P/\partial I)_V$

NOMENCLATURE (continued)

ρ_o initial density in g/cc

Subscript

H Hugoniot

Superscript

f foam

THE EXPERIMENTAL DATA

Polyurethane foam is not so uniform as nonfoamed substances, and, therefore, the experimental equation-of-state data obtained for foam have considerably greater error than is usually present in such studies.

The equation of state of singly shocked 0.5-g/cc polyurethane can be approximated up to 100 kbar by $U_s = 0.015 + 1.5\ U_p$;[1] that of 0.62-g/cc polyurethane can be approximated up to 400 kbar by $U_s = 0.01 + 1.62\ U_p$.[1,2] The spread of the experimental data is such that the constants in the equations are not known to within $\pm$ 0.05, and the linear relationship between shock velocity and particle velocity is only one of many possible relationships that could be used to fit the data. For 1.265-g/cc bulk-density polyurethane, the equation of state of the single-shock Hugoniot is described by $U_s = 0.275 + 1.57\ U_p$.[1]

Carter[3] has measured the pressure of the reflected shock in 1.27 cm of 0.5-g/cc polyurethane initially shocked to about 115 kbar in contact with 0.482 cm of 2024 aluminum, 0.635 cm of AZ31B magnesium, or 0.444 cm of copper. The foam was initially shocked to 115 kbar by a P-80 plane-wave lens and 20.32 cm of Composition B-3 explosive. The shock velocities in the metals were measured to within 1%. The results are shown below.

Metal	Measured Shock Velocity (cm/μsec)	Pressure (mbar)	Particle Velocity (cm/μsec)
Cu (ρ_o=8.928)	0.532	0.442	0.093
Al (ρ_o=2.777)	0.747	0.331	0.160
Mg (ρ_o=1.77)	0.710	0.261	0.208

The measured shock velocity through 0.762 cm of additional foam in contact with the 1.27 cm of foam was about 0.57 cm/μsec.

The results are surprising when one realizes that the pressures and velocities in the metals are within a few percent of what one would obtain if the Composition B explosive were in direct contact with the metals. That is to say that the 0.5-g/cc foam appears to behave about the same as 1.715-g/cc high explosive in this experimental geometry. The results are also surprising in that the pressures and velocities in the metals using 0.5-g/cc foam are within about 10% of what one expects to obtain by replacing the foam with 1.265-g/cc polyurethane. The results of such experiments performed for 1.17-g/cc polyurethane are shown below.

Metal	Measured Shock Velocity (cm/μsec)	Pressure (mbar)	Particle Velocity (cm/μsec)
Cu	0.546	0.500	0.1026
Al	0.754	0.350	0.167
Mg	0.726	0.285	0.2218

Experiments were also performed for 0.96-g/cc polyurethane, and the measured shock velocity in the copper was 0.548 and that in the magnesium was 0.725. For 0.62-g/cc polyurethane, the measured shock velocity in the copper was 0.538 and that in the magnesium was 0.711.

SOLID EQUATIONS OF STATE

We attempted to use some of the proposed equations of state for foam to fit the single- and double-shock experimental data described in the preceding section.

A successful method for solids and liquids has been to describe the single-shock Hugoniot with an experimentally calibrated linear relationship between shock and particle velocity. State points off the single-shock Hugoniot were determined using the Grüneisen equation of state,

$$P - P_H = (\gamma/V)(I - I_H),$$

where γ is calibrated for the range of state points of interest.[4,5] Using the copper double-shock data, one can calculate the specific volume of the foam as follows. If the 0.5-g/cc foam Hugoniot is described by $U_s = 0.015 + 1.5\ U_p$, Composition B explosive interacts with the foam giving a shock of 0.117 mbar, a shock velocity of 0.60 cm/μsec, a particle velocity of 0.390 cm/μsec, a specific volume of 0.70 cc/g, and an energy of 0.07605 mbar-cc/g.

Using the equations

$$U_p - U_p' = \sqrt{(P - P')(V' - V)}$$

and

$$I - I' = 0.5(P + P')(V' - V),$$

where the prime-state values are single-shock values and the nonprime values are double-shocked state values, one calculates that the specific volume of the copper doubly shocked polyurethane foam is 0.433 cc/g and the energy is 0.1512 mbar-cc/g.

The single-shock Hugoniot pressure of a substance with a linear relationship between shock and particle velocity, $U_s = C + S\,U_p$, can be calculated from

$$P_H = C^2(V_o - V)/[V_o - S(V_o - V)]^2.$$

P_H goes to infinity when $[V_o - S(V_o - V)]$ goes to zero or when $V = V_o(S - 1)/S$. The Hugoniot pressure for the foam using this equation goes to infinity when the volume of the foam decreases to 0.666 cc/g. Since the doubly shocked polyurethane foam volume is less than the infinite pressure volume with this solid equation of state, the assumed form of the solid equation of state is inadequate to describe the polyurethane foam under double-shock conditions.

McQueen and Marsh[5] have shown that the experimentally measured Hugoniots of foamed metals can be approximated using the Hugoniot equation of state of the metal at crystal density and the Grüneisen equation of state to correct for the higher energy of the foamed metal at the same shocked volume. Substituting into the Grüneisen equation of state the Hugoniot energy of the metal, $0.5\,P_H(V_o - V)$, and of the foam, $0.5\,P_H^f(V_o^f - V)$, one obtains

$$P_H^f - P_H = \frac{(V_o^f - V_o)P_H}{(2V/\gamma - V_o^f + V)},$$

from which one can calculate a γ of 0.944 for polyurethane foam shocked to 0.117 mbar.

Using the bulk-density Hugoniot and the Grüneisen equation of state requires a γ of 0.65 to reproduce the observed copper doubly shocked polyurethane point, a γ of 0.56 to reproduce the aluminum doubly shocked polyurethane point, and a γ of 0.46 to reproduce the magnesium doubly shocked point. The gamma decreases with increasing volume for the doubly shocked points and then increases for the singly shocked point. While this curious behavior of gamma could be reproduced by various complicated relationships between gamma and volume, it does not suggest any unique relationship. The other difficulty with the McQueen and Marsh foam model is that one does not know how to describe the expansion of the foam that has been shocked to high pressures and decomposed by the resulting high temperatures.

Herrmann[6] has considered the problem of how to describe the low pressure end of the foam Hugoniot. Such a treatment should probably be included in any general equation of state of foam. He does not consider the case of foams shocked to high enough pressures and temperatures to decompose them. Thouvenin's[7] treatment of foams does not reproduce the observed single-shock Hugoniot data for 0.5 g/cc polyurethane.

BKW GAS EQUATION OF STATE

Since the 0.5-g/cc polyurethane foam shocked to 100 kbar is very hot (approximately 3000° K estimated using the Walsh and Christian technique for calculating temperatures[4]), it is reasonable to assume that the polyurethane decomposed to its equilibrium decomposition products.

The BKW equation of state[8-11] has been calibrated for carbon-hydrogen-nitrogen-oxygen explosives in the pressure and temperature range of interest. Calculations made using it reproduce the experimentally observed shock Hugoniots of water, carbon dioxide, and nitrogen above 50 kbar.[10] It seems to be a reasonable equation of state for describing the equilibrium decomposition products of polyurethane. We have used the BKW equation to describe the equation of state of 0.5- and 0.3-g/cc foam above 50 kbar. The results are not very sensitive to the exact chemical, or even elemental, composition, which is fortunate since the composition of foams varies considerably from batch to batch.

As shown in Figs. 1 and 2, the calculated single-shock Hugoniots agree with the experimental data within the experimental error of the data. The results of the calculations are given in Appendixes A and B for a pure urethane foam and in Appendixes C and D for polymerized mixtures of polyurethane and adipic acid with an empirical formula of $(C_{12.5}H_{17.87}N_1O_{4.938})_x$ obtained by chemical analysis. Figure 3 shows the isentrope through a Hugoniot point near the single-

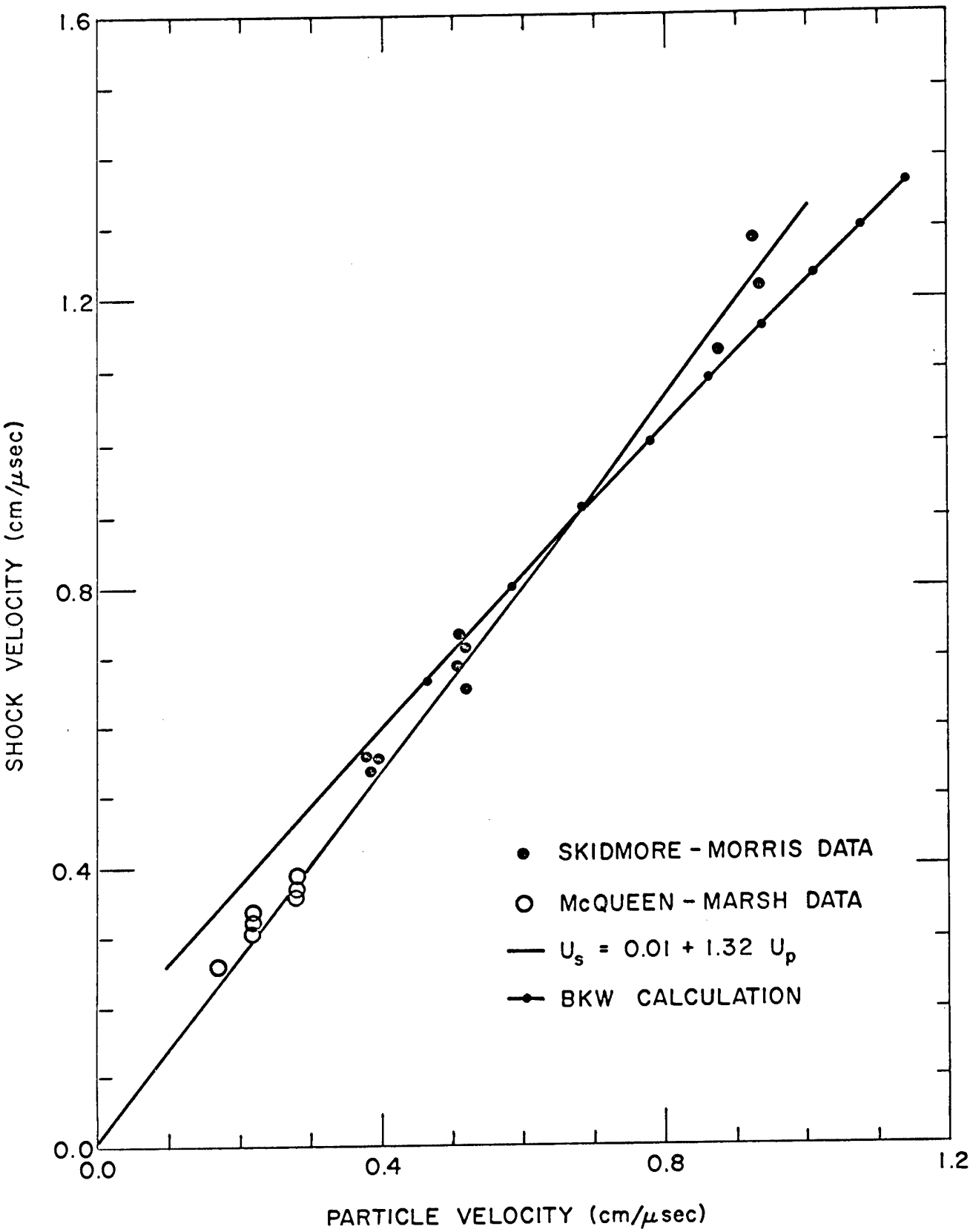

Fig. 1. The experimental and calculated Hugoniot curves for 0.32-g/cc polyurethane.

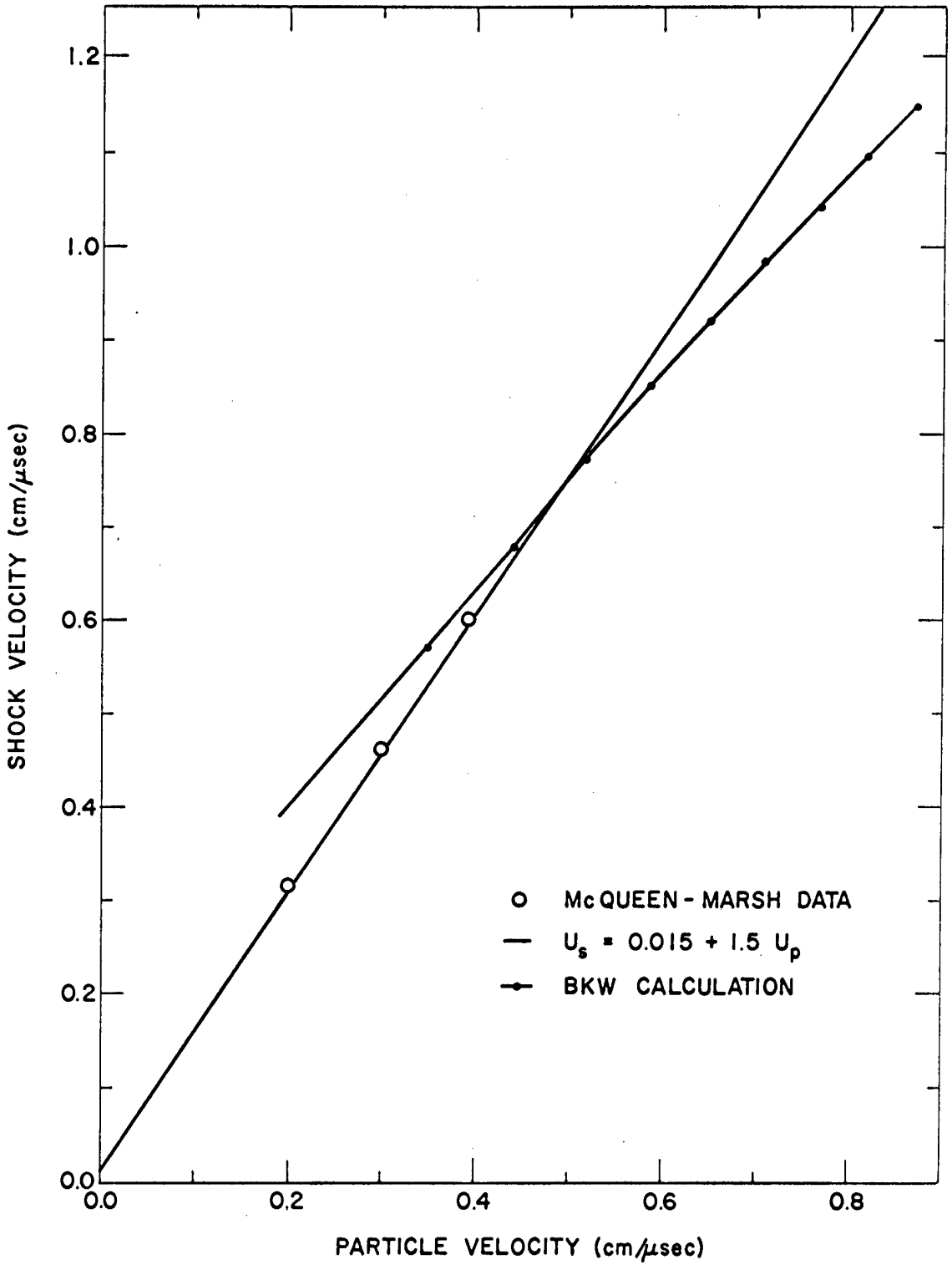

Fig. 2. The experimental and calculated Hugoniot curves for 0.5 g/cc polyurethane.

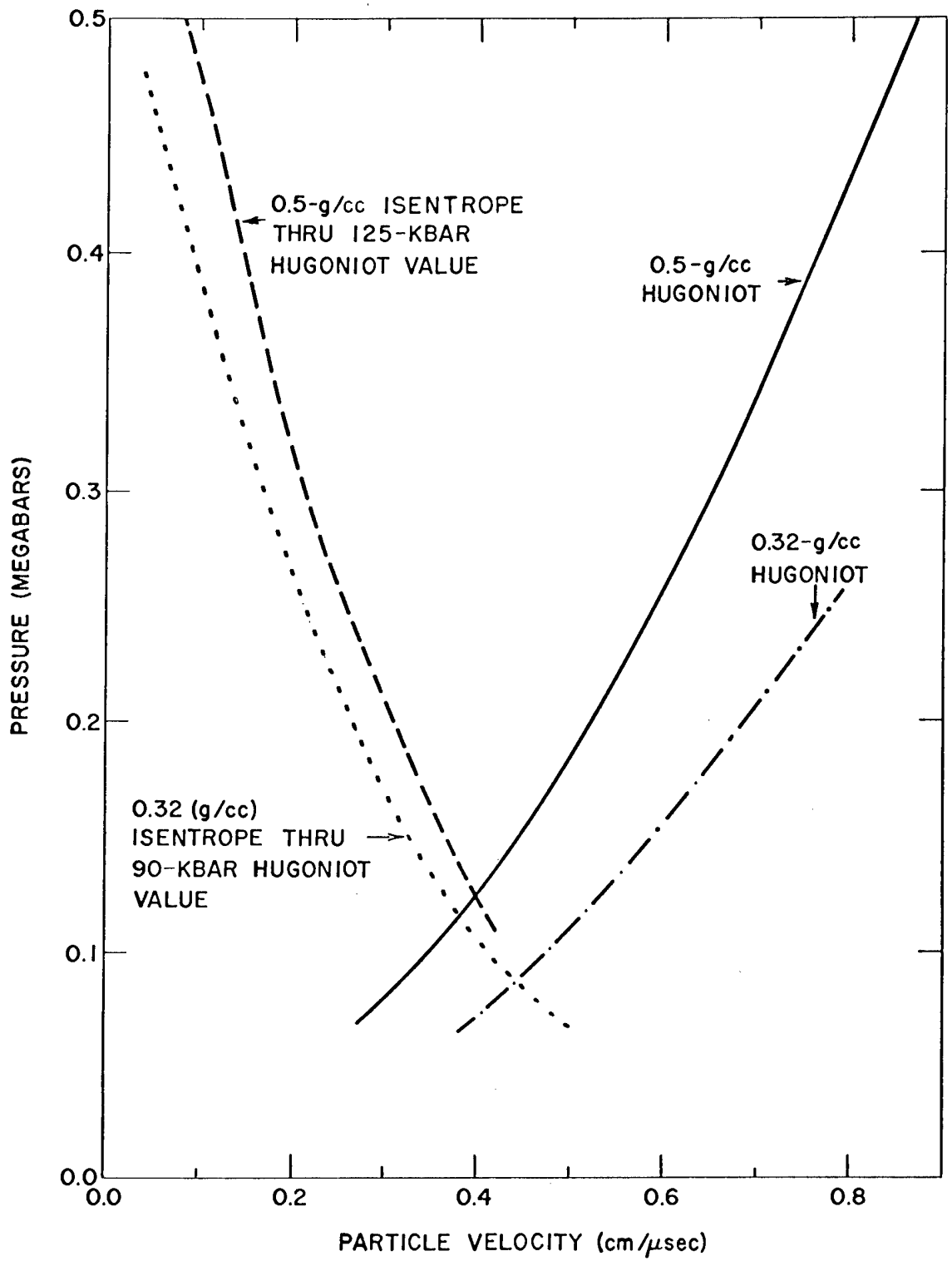

Fig. 3. The calculated BKW Hugoniots and isentropes for 0.5- and 0.32-g/cc polyurethane.

shock Hugoniot value for the foam being shocked by Composition B for 0.32- and 0.5-g/cc polyurethane foam.

Using the HOM equation of state and the SIN one-dimensional hydrodynamic code[4] with the BKW description of the isentrope of the decomposition products and "burning" the foam by either a sharp shock burn or a "C-J volume burn" technique gives us the following results for the reflected shock experiments.

Metal	Calc. Pressure	Exper. Pressure	Calc. Particle Velocity	Exper. Particle Velocity
Cu	0.425	0.442	0.090	0.093
Al	0.330	0.331	0.158	0.160
Mg	0.266	0.261	0.211	0.208

The bulk-density polyurethane shocked to 100 kbar does not get very hot (800°K estimated using Walsh and Christian technique for calculating temperatures) and it probably does not decompose to equilibrium decomposition products until it reaches much higher pressures and temperatures. The BKW equation-of-state Hugoniot for bulk-density polyurethane does not approach the experimental Hugoniot data until high pressures as is shown in Fig. 4. Using the solid HOM equation of state and a gamma of 1.0, we calculate the following results for the reflected shock experiment.

Metal	Calculated Pressure	Experimental Pressure
Cu	0.496	0.500
Al	0.364	0.350
Mg	0.281	0.285

CONCLUSIONS

The experimentally observed behavior of high explosive-foam-metal systems can be reproduced if the low density (0.5- and 0.3-g/cc) polyurethane foams are described by the BKW equation of state and if the initial shock pressures are greater than 50 kbar.

If the shock pressures are low enough, or if the density of the foam is high enough, or both, the polyurethane does not become hot enough to decompose and the appropriate form for the equation of state is a solid rather than a gas. One can imagine experimental systems in which the polyurethane would not be shocked to great enough pressures and temperatures to decompose on the first shock, but would be heated enough by subsequent shocks to partially or totally decompose. For such systems, a mixture equation such as the HOM equation of state is indicated.

The most important conclusion to be drawn from this work is that if foams are to be realistically described in numerical hydrodynamic calculations, experimental equation-of-state data in all the pressure and energy regions of interest will be needed to calibrate the foam equation of state properly. A general foam equation of state should describe solid, gaseous, and mixed solid and gaseous states with appropriate temperature-sensitive kinetics. Additional experimental and theoretical studies of foams should be rewarding.

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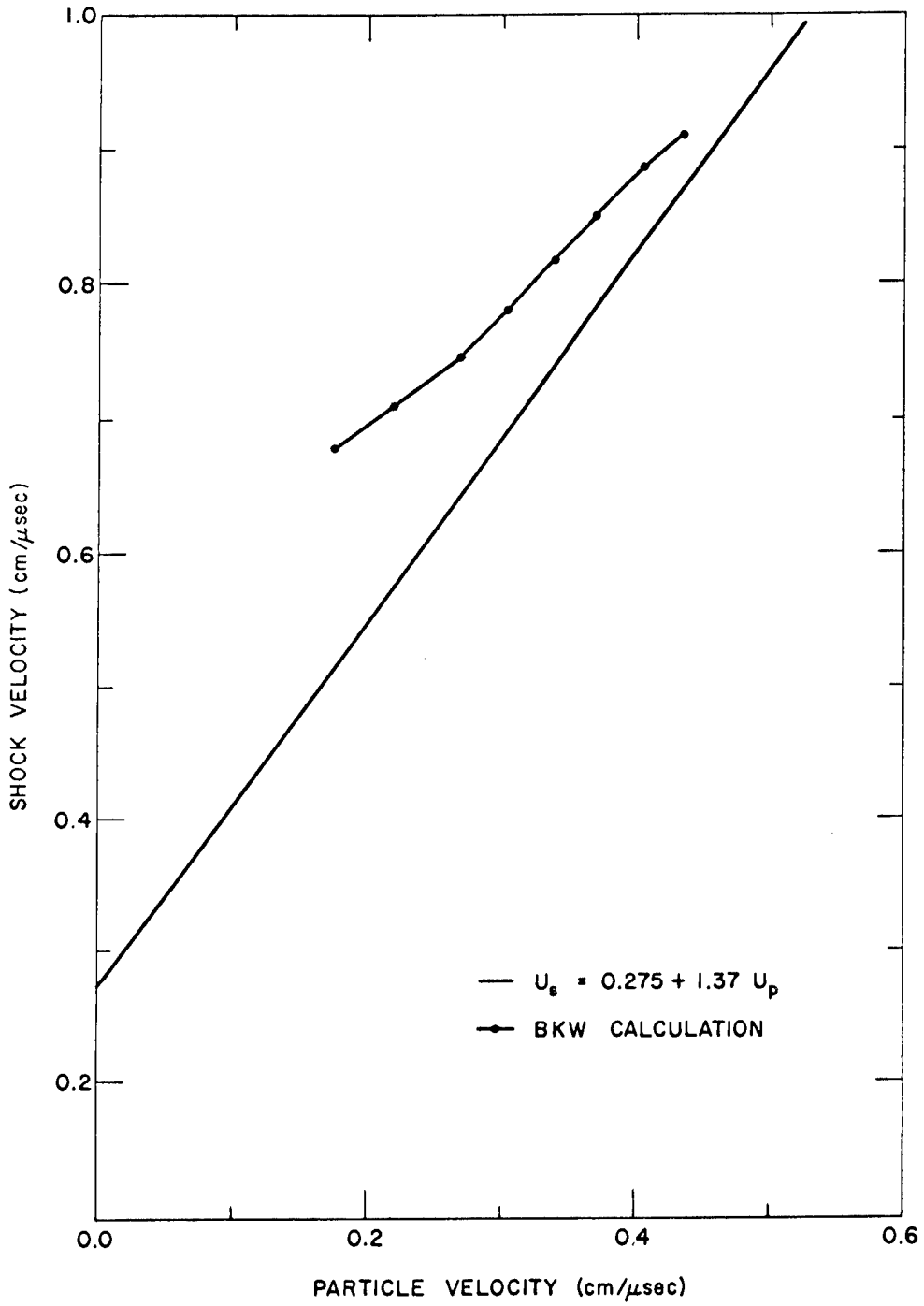

Fig. 4. The experimental and calculated Hugoniot curves for 1.265-g/cc polyurethane.

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APPENDIX A.

THE BKW HUGONIOT FOR 0.5-g/cc POLYURETHANE FOAM AND THE ISENTROPE THROUGH THE 125-kbar HUGONIOT VALUE

```
 A FOR7RAN 8KW CALCULA71ON FOR
URE THANE FOAM

7HE NUMBER OF ELEMEN78 1S      4

7HE NUMBER OF GAS 8PEC1E8 1S     11

THE NUMBER OF 8OL10 SPEC1E8 1S      1

7HE 8KW EQUA71ON OF STATE PARAME TER8 ARE
 ALPHA= 5.000000000000E-01 8ETA= 1.600000000000E-01 THETA= 4.000000000000E+02 KAPPA= 1.090977844 36E+01

7HE COMPO81T1ON
     3.000000000000E+00 MOLE8 OF    C
     7.000000000000E+00 MOLE8 OF    H
     1.000000000000E+00 MOLE8 OF    N
     2.000000000000E+00 MOLE8 OF    O

7HE DEN8177                    1S  5.000000000000E-01, GRAM8/CC

7HE MOLECULAR WE1GH7 1S  8.909400000000E+01 GRAM8

THE HEA7 OF FORMA71ON AT 0 0EG K 1S -7.700000000000E+04 CALORIE8 PER FORMULA WEIGHT

7HE 8OL10 (COWAN) EQUAT1ON OF STATE PARAME TER8     VO, A8, B8, C8, D8, E8,      A1, A2, C1, C2, C3, ATOMIC WT

8OL C   4.444444444444E-01   8.30935837268E-01  -1.39381809219E+00   6.72569716021E-01  -1.13537262508E-01   6.49155882007E-03
       -2.26705345948E-01   1.20516569525E-01   8.31600000000E-02  -1.75590000000E-01   1.55310000000E-01   1.20100000000E+01

7HE 1NPU7              PRODUCT ELEMENTAL COMPOSITION MATRIX
  0         2.0E+00   0         1.0E+00   0         2.0E+00   0         0         0         0         0         2.0E+00
  1.0E+00   0         0         2.0E+00   1.0E+00   0         0         1.0E+00   0         3.0E+00   1.0E+00   0
  0         1.0E+00   0         0         0         0         1.0E+00   1.0E+00   0         0         2.0E+00   0
  0         1.0E+00   0         1.0E+00   1.0E+00   4.0E+00   0         0         1.0E+00   0         0         0



 7HE 8KW HUGON1OT FOR
URE7HANE FOAM

PRE88URE =  5.000000000000E-01 VOLUME =  4.830813183 72E-01 TEMPERATURE =  7.860456299 10E+03
8HOCK VELOC177 =  1.148241961 08E+00 PARTICLE VELOCITY = 8.708948408 94E-01 UNITS ARE M8ARS,CC/GM, DEG K, AND CM/MICROSECOND

 8PEC1E   NO OF MOLE8
H20      1.763689069 17E+00
H2       2.365687572 01E-01
O2       2.855358027 61E-04
CO2      1.116793834 78E-02
CO       2.047851763 54E-01
NH3      2.213055479 83E-01
H        2.034821176 77E-02
NO       7.276520649 54E-03
N2       3.857089656 84E-01
OH       1.342639527 57E-03
CH4      5.784692130 05E-01
8OL C    2.205577672 29E+00
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```
PRESSURE =  4.500000000000E-01 VOLUME =  5.040657340 61E-01 TEMPERATURE =  7.590251234 29E+03
SHOCK VELOCITY =  1.096931517 19E+00 PARTICLE VELOCITY = 8.204687219 74E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

 SPECIE    NO OF MOLES
H20       1.733108094 46E+00
H2        2.477204274 57E-01
O2        2.471150856 15E-04
CO2       1.261063903 81E-02
CO        2.331450034 33E-01
NH3       2.160371549 58E-01
H         1.964616136 94E-02
NO        6.588832243 87E-03
N2        3.682870063 99E-01
OH        1.442560013 70E-03
CH4       5.916856924 76E-01
SOL C     2.162558664 25E+00

PRESSURE =  4.000000000000E-01 VOLUME =  5.279018078 66E-01 TEMPERATURE =  7.276133058 03E+03
SHOCK VELOCITY =  1.042535995 63E+00 PARTICLE VELOCITY = 7.673576771 99E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

 SPECIE    NO OF MOLES
H20       1.708460919 95E+00
H2        2.619165726 25E-01
O2        1.990797715 71E-04
CO2       1.390391425 03E-02
CO        2.611474506 48E-01
NH3       2.120750030 76E-01
H         1.863820893 84E-02
NO        5.688072407 43E-03
N2        3.911184622 58E-01
OH        1.497568946 24E-03
CH4       6.032210569 32E-01
SOL C     2.121727578 17E+00

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SHOCK VELOCITY =  9.843426656 92E-01 PARTICLE VELOCITY = 7.111324303 24E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

 SPECIE    NO OF MOLES
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H2        2.795666618 03E-01
O2        1.439346345 32E-04
CO2       1.482217553 69E-02
CO        2.847230925 37E-01
NH3       2.066963869 67E-01
H         1.709613786 27E-02
NO        4.566020391 87E-03
N2        3.943687963 21E-01
OH        1.467650073 58E-03
CH4       6.108897235 62E-01
SOL C     2.089556808 36E+00

PRESSURE =  3.000000000000E-01 VOLUME =  5.860611875 40E-01 TEMPERATURE =  6.432114605 82E+03
SHOCK VELOCITY =  9.212430278 91E-01 PARTICLE VELOCITY = 6.512912019 9TE-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

 SPECIE    NO OF MOLES
H20       1.670026205 14E+00
H2        3.004458730 77E-01
O2        8.706338046 89E-05
CO2       1.498507586 13E-02
CO        2.952894020 54E-01
NH3       2.002347739 42E-01
H         1.464501907 54E-02
NO        3.244883617 33E-03
N2        3.982601712 20E-01
OH        1.295190707 44E-03
CH4       6.106028279 91E-01
SOL C     2.079122694 09E+00
```

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H2	3.21732117245E-01
O2	3.77142804880E-05
CO2	1.37310321781E-02
CO	2.75610673624E-01
NH3	1.92119065123E-01
H	1.07903590268E-02
NO	1.82897562593E-03
N2	4.03025979626E-01
OH	9.24273283991E-04
CH4	5.95066692184E-01
SOL C	2.11559160201E+00

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O2	7.96758009970E-06
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CO	2.01401870044E-01
NH3	1.82454999627E-01
H	5.57043606799E-03
NO	6.25224811095E-04
N2	4.08459887781E-01
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CH4	5.56848302119E-01
SOL C	2.23159392285E+00

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SPECIE	NO OF MOLES
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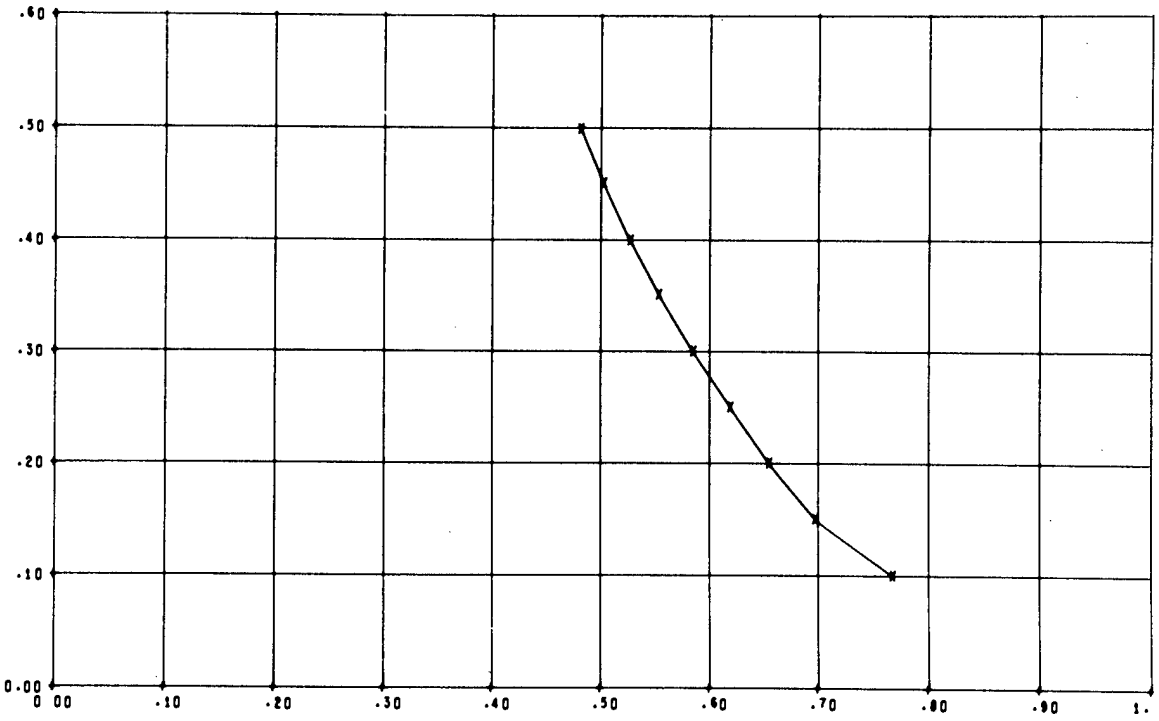
O2	3.89169456944E-07
CO2	5.05743536471E-03
CO	9.11650534331E-02
NH3	1.74747360512E-01
H	1.35409126157E-03
NO	7.70665640590E-05
N2	4.12587786462E-01
OH	7.31236302295E-05
CH4	5.14001162958E-01
SOL C	2.38977634824E+00

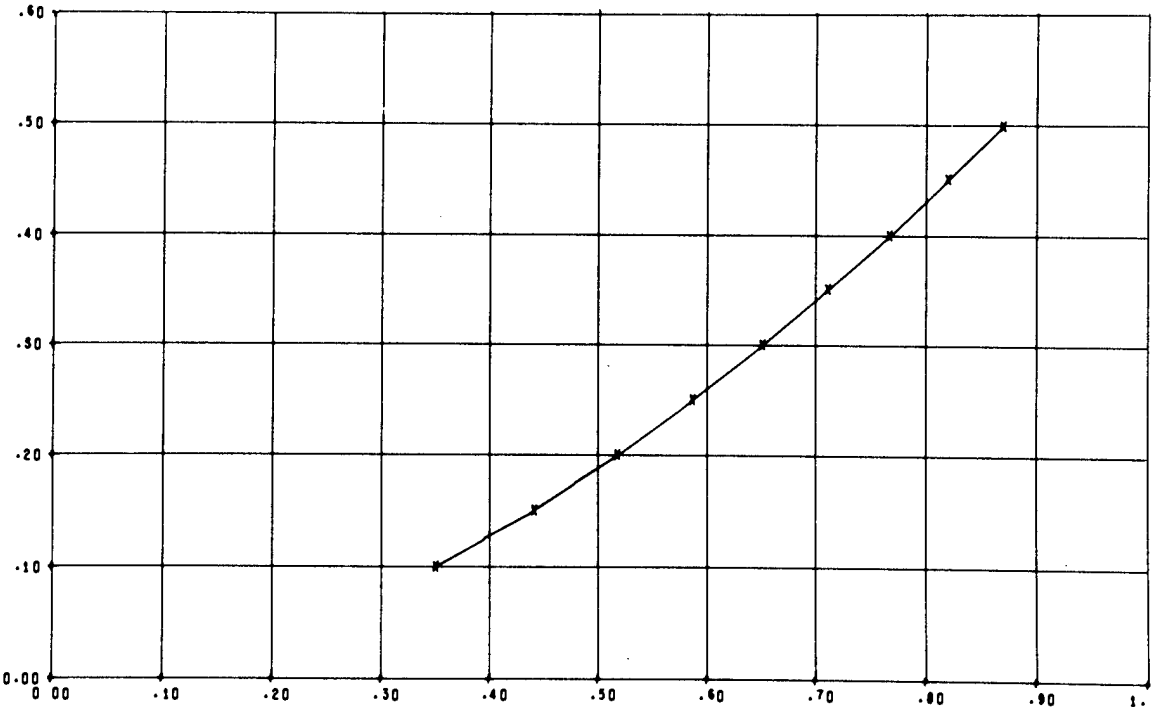
PRESSURE = 1.00000000000E-01 VOLUME = 7.68197404213E-01 TEMPERATURE = 2.87765215543E+03
SHOCK VELOCITY = 5.69845688490E-01 PARTICLE VELOCITY = 3.50968699140E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H20	1.96966241373E+00
H2	2.55375542362E-01
O2	3.00096687504E-10
CO2	2.04135141713E-03
CO	2.62484189370E-02
NH3	1.67974730213E-01
H	1.09366793562E-04
NO	2.20958530956E-06
N2	4.16011530101E-01
OH	4.25431342379E-06
CH4	5.11471569017E-01
SOL C	2.46023666063E+00



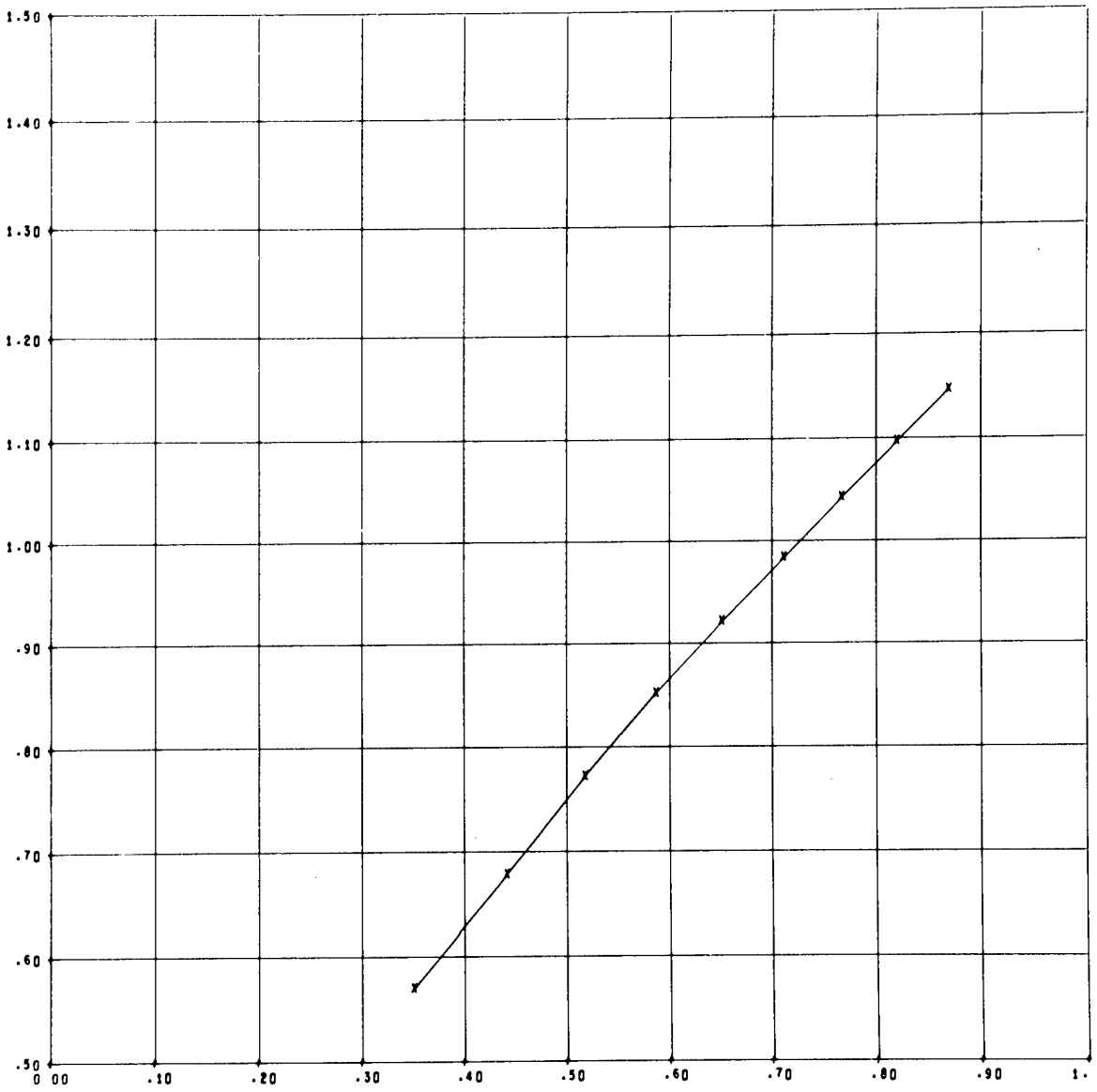
URETHANE FOAM

PRESSURE (MBARS) - VOLUME (CC/GM) HUGONIOT



URETHANE FOAM

PRESSURE (MBARS) - PARTICLE VELOCITY (CM/USEC) HUGONIOT



URETHANE FOAM

SHOCK VELOCITY - PARTICLE VELOCITY HUGONIOT

DISPLACED BKW ISENTROPE
URETHANE FOAM

LN(P)=-2.8777951743I+000 -2.42032345464+000LNV 4.27749466879-001 LNV**2 9.99490570255-002LNV**3 -1.80921107459-001LNV**4

LN(T)= 7.96614913339+000 -5.02035683863-001LNV 2.85383843462-002 LNV**2 4.70214900451-002LNV**3 -5.39270358998-003LNV**4

LN(E)=-1.07970936962+000 4.89000359014-001LNP 1.24679928418-001 LNP**2 2.09847517288-002LNP**3 1.49538560967-003LNP**4

THE CONSTANT ADDED TO ENERGIES WAS 1.00000000000-001

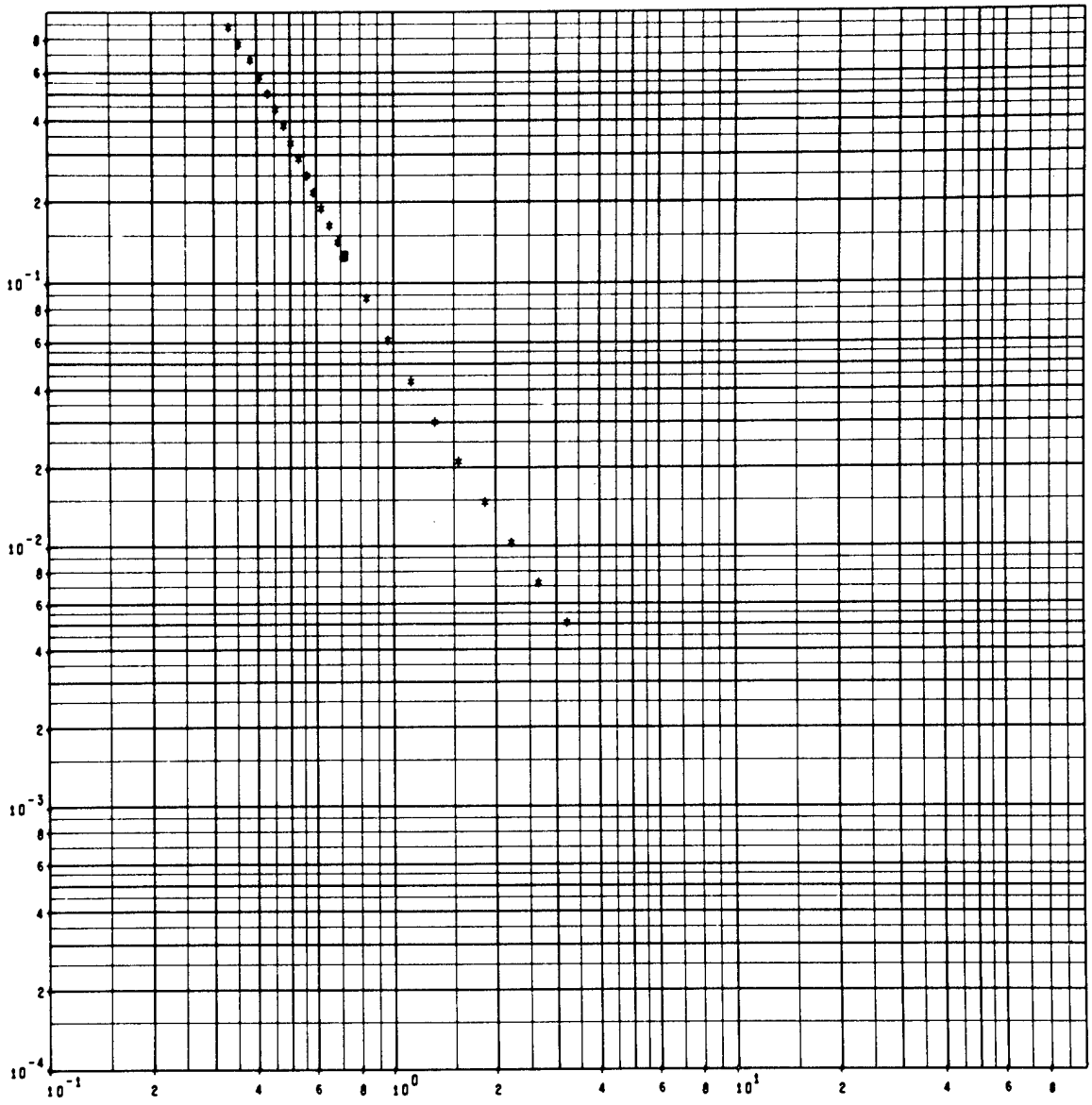
PRESSURE (MBARS)	VOLUME (CC/GM)	TEMPERATURE (DEG K)	ENERGY+C (MB-CC/GM)	GAMMA (-DLNP/DLNV)	PARTICLE VELOCITY
1.25000000000-001	7.26998426293-001	3.38938476009+003	1.79563240966-001	2.63914784133+000	3.98904997103-001
8.75000000000-002	8.36015633189-001	3.15580689623+003	1.68208995685-001	2.55977304182+000	4.63541295910-001
6.12500000000-002	9.67692930909-001	2.92601484838+003	1.58553112386-001	2.44806941936+000	5.22951560836-001
4.28750000000-002	1.12828955871+000	2.70748837166+003	1.50327996628-001	2.31396642320+000	5.77514337705-001
3.00125000000-002	1.32479668983+000	2.50488487160+003	1.43295997652-001	2.17208835787+000	6.27453711033-001
2.10087500000-002	1.56539388256+000	2.32118779718+003	1.37275981050-001	2.04185514702+000	6.73137081605-001
1.47061250000-002	1.86018339507+000	2.15735238061+003	1.32115178680-001	1.94686245994+000	7.15168450089-001
1.02942875000-002	2.22224594820+000	2.01272651429+003	1.27676972585-001	1.91447136501+000	7.54356963494-001
7.20600125000-003	2.66902317293+000	1.88569400662+003	1.23839040547-001	1.97619189018+000	7.91610526010-001
5.04420087500-003	3.22412862289+000	1.77420715335+003	1.20494543328-001	2.16892990873+000	8.27758199863-001
1.43750000000-001	6.8946926I866-001	3.48409995751+003	1.84661740758-001	2.65976515003+000	0.00000000000+000
1.65312500000-001	6.54264881577-001	3.57722284116+003	1.90093375254-001	2.67403799553+000	0.00000000000+000
1.90109375000-001	6.21232353702-001	3.67045579880+003	1.95953136498-001	2.68155719311+000	0.00000000000+000
2.18625781250-001	5.90142144521-001	3.76373628376+003	2.02293275261-001	2.68194927525+000	0.00000000000+000
2.51419648437-001	5.60782920340-001	3.85708293154+003	2.09176421178-001	2.67479234991+000	0.00000000000+000
2.89132595703-001	5.32956056005-001	3.95056432097+003	2.16677049362-001	2.65958507948+000	0.00000000000+000
3.32502485059-001	5.06470285083-001	4.04433110038+003	2.24885623885-001	2.63570262047+000	0.00000000000+000
3.82377857817-001	4.81132907844-001	4.13866732081+003	2.33915246007-001	2.60232723028+000	0.00000000000+000
4.39734536490-001	4.56733723361-001	4.23410915800+003	2.43914538975-001	2.55832271677+000	0.00000000000+000
5.05694716963-001	4.33009633059-001	4.33172422790+003	2.55096350608-001	2.50196654725+000	0.00000000000+000
5.81548924508-001	4.09546676143-001	4.43390990725+003	2.67817054442-001	2.43023659911+000	0.00000000000+000
6.68781263184-001	3.85396937937-001	4.54754437345+003	2.82886505087-001	2.33611123070+000	0.00000000000+000
7.69098452662-001	3.57208233678-001	4.70215661579+003	3.03145434836-001	2.19375330461+000	0.00000000000+000
8.84463220561-001	3.34491670394-001	4.84354062679+003	3.21739874450-001	2.04707721914+000	0.00000000000+000

THE ISENTROPE STATE VARIABLES AS COMPUTED FROM THE LEAST SQUARE FIT

BKW PRESSURE	FIT PRESSURE	BKW TEMPERATURE	FIT TEMPERATURE	BKW ENERGY PLUS CONSTANT	FIT ENERGY
1.25000000000-001	1.26470284279-001	3.38938476009+003	3.38644159896+003	1.79563240966-001	1.79396096601-001
8.75000000000-002	8.79194371702-002	3.15580689623+003	3.15488556485+003	1.68208995685-001	1.68341997894-001
6.12500000000-002	6.09407585591-002	2.92601484838+003	2.92972934526+003	1.58553112386-001	1.58967101960-001
4.28750000000-002	4.22747318928-002	2.70748837166+003	2.71364854556+003	1.50327996628-001	1.50843013513-001
3.00125000000-002	2.94929657779-002	2.50488487160+003	2.51044951798+003	1.43295997652-001	1.43703197830-001
2.10087500000-002	2.07578521886-002	2.32118779718+003	2.32369475943+003	1.37275981050-001	1.37405252714-001
1.47061250000-002	1.47251839850-002	2.15735238061+003	2.15594628008+003	1.32115178680-001	1.31904782826-001
1.02942875000-002	1.04578893824-002	2.01272651429+003	2.00863435635+003	1.27676972585-001	1.27237447033-001
7.20600125000-003	7.33506083802-003	1.88569400662+003	1.88235379697+003	1.23839040547-001	1.23508170860-001
5.04420087500-003	4.96962700100-003	1.77420715335+003	1.77730807234+003	1.20494543328-001	1.20888272757-001
1.43750000000-001	1.45541378578-001	3.48409995751+003	3.47812251948+003	1.84661740758-001	1.84317189847-001
1.65312500000-001	1.67378918960-001	3.57722284116+003	3.57065947223+003	1.90093375254-001	1.89642429457-001
1.90109375000-001	1.92292717719-001	3.67045579880+003	3.66381748230+003	1.95953136498-001	1.95430218500-001
2.18625781250-001	2.20684923121-001	3.76373628376+003	3.75762209331+003	2.02293275261-001	2.01748413416-001
2.51419648437-001	2.53014116553-001	3.85708293154+003	3.85213201142+003	2.09176421178-001	2.08675928499-001
2.89132595703-001	2.89810422820-001	3.95056432097+003	3.94745171599+003	2.16677049362-001	2.16304700481-001
3.32502485059-001	3.31697758963-001	4.04433110038+003	4.04374787040+003	2.24885623885-001	2.24742104232-001
3.82377857817-001	3.79433306461-001	4.13866732081+003	4.14128363108+003	2.33915246007-001	2.34113935565-001
4.39734536490-001	4.33986032846-001	4.23410915800+003	4.24049185805+003	2.43914538975-001	2.44568109877-001
5.05694716963-001	4.96718678525-001	4.33172422790+003	4.34215063451+003	2.55096350608-001	2.56279268337-001
5.81548924508-001	5.69905671602-001	4.43390990725+003	4.44788876970+003	2.67817054442-001	2.69454540382-001
6.68781263184-001	6.58786423924-001	4.54754437345+003	4.56219355806+003	2.82886505087-001	2.84340787104-001
7.69098452662-001	7.82591792689-001	4.70215661579+003	4.70251413120+003	3.03145434836-001	3.01233751870-001
8.84463220561-001	8.99699124717-001	4.84354062679+003	4.82063107241+003	3.21739874450-001	3.20489681658-001

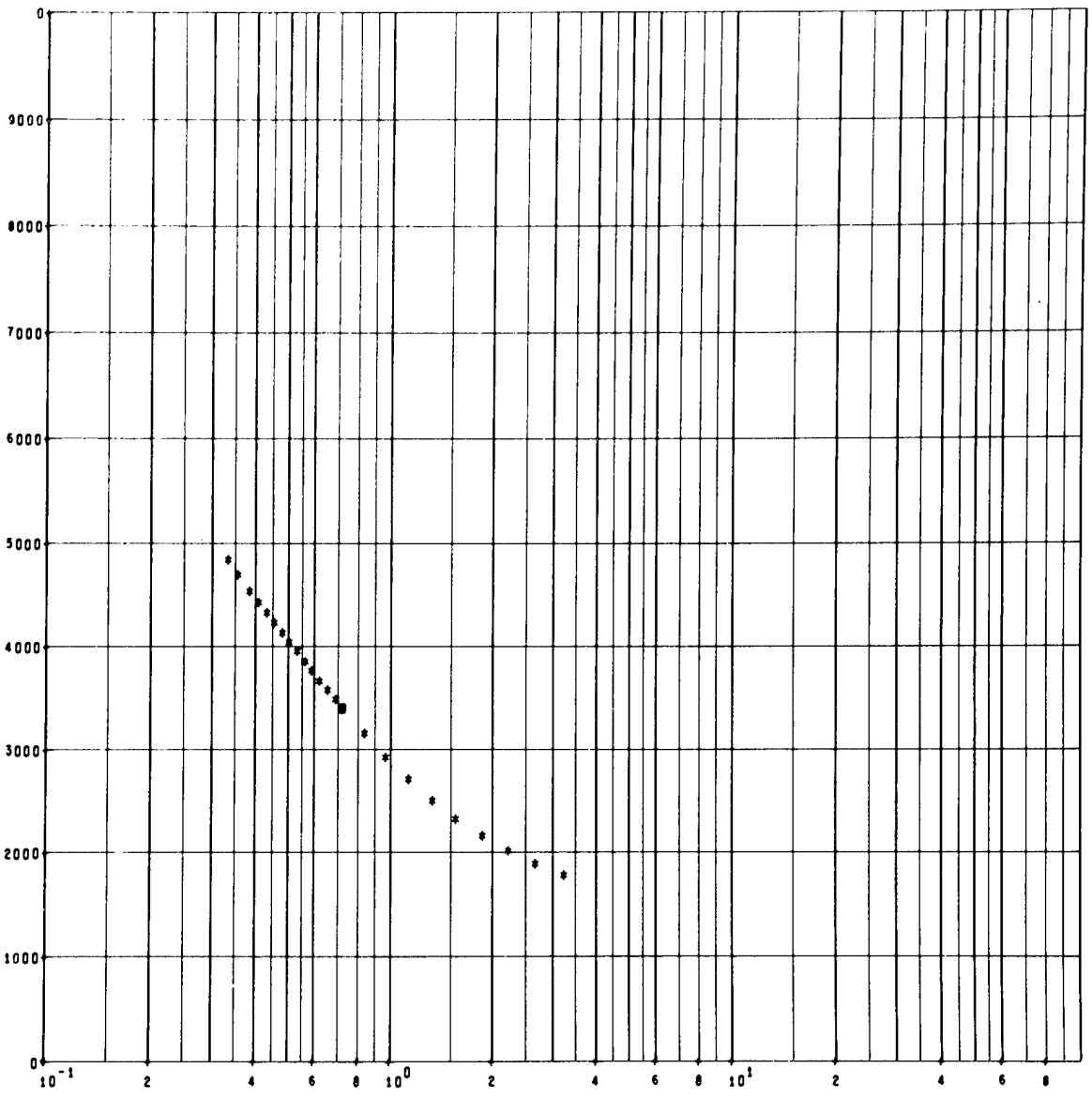
THE ISENTROPE PRESSURE AND COMPOSITION OF PRODUCTS

H2O	H2	O2	CO2	CO	NH3	H	NO	K2	OH	CH4	SOL C		
1.25000000000-001				1.94293498237+000				2.85546241759-001		4.05839841036-008		3.17354519317-003	5.06617297420-002
1.72235399631-001				4.46437806178-004				1.59667591177-005		4.13874326805-001		2.01695791218-005	5.06465686348-001
2.43967903672+000													
8.75000000000-002				1.68901642015+000				3.92779438434-001		5.78585000343-010		6.76151842881-003	9.66229561106-002
1.41314142330-001				4.27236426810-004				1.04212983806-005		4.29337716186-001		2.71644278853-005	5.02602863748-001
2.39401266171+000													
6.12500000000-002				1.61254366049+000				5.02161668888-001		4.69598313156-010		1.26983376726-002	1.62025068544-001
1.15463087860-001				3.46976552002-004				5.70120416006-006		4.42265605425-001		2.86934189430-005	5.05956001904-001
2.31932059188+000													
4.28750000000-002				1.71353035630+000				6.07156700946-001		3.47036009038-010		2.14043401386-002	2.43633511368-001
9.44521357041-002				2.46967300359-004				2.67038939561-006		4.52772596953-001		2.47809738788-005	5.18749432532-001
2.21621271596+000													
3.00125000000-002				1.60059330613+000				7.03295976635-001		2.27045873609-010		3.28732377045-002	3.33640990542-001
7.74807625703-002				1.58037004014-004				1.09773870870-006		4.61259069845-001		1.81297256324-005	5.39900745007-001
2.09356502675+000													
2.10087500000-002				1.48325274629+000				7.68024569239-001		1.25063506353-010		4.68107484202-002	4.23113695444-001
6.36934800959-002				9.33295742914-005				4.06701079303-007		4.68153055202-001		1.16524772721-005	5.66564986052-001
1.96351057000+000													
1.47061250000-002				1.36985563620+000				8.60285983279-001		5.24360980267-011		6.28178840918-002	5.04501651017-001
5.24308775513-002				5.20775787387-005				1.42194275079-007		4.73784490137-001		6.80224186942-006	5.95591312128-001
1.85708915276+000													
1.02942675000-002				1.26629256426+000				9.20244320376-001		1.42288601405-011		8.05095374821-002	5.72684604501-001
4.32204951189-002				2.79969946204-005				4.74954230687-008		4.78385728693-001		3.70875321813-006	6.24308256907-001
1.72249760111+000													
7.20600125000-003				1.17590507610+000				9.60958577055-001		1.00000000000-011		9.95590563597-002	6.24974879778-001
3.57040282885-002				1.47224716272-005				5.19999683248-010		4.82147585596-001		1.93088421246-006	6.50785388866-001
1.62468067500+000													
5.04420087500-003				1.09998698888+000				1.00802963436+000		1.00000000000-011		1.19692987438-001	6.60626059867-001
2.95898311900-002				7.65784443155-006				3.79695216023-010		4.85205084215-001		9.76033001122-007	6.73797156517-001
1.54560379618+000													
1.43750000000-001				1.95718899393+000				2.46762134517-001		4.74876724011-008		2.28847612080-003	3.81988943586-002
1.85437200938-001				4.40701451781-004				1.81561457118-005		4.07272317458-001		1.69083530748-005	5.08832126624-001
2.45068050290+000													
1.65312500000-001				1.96071969053+000				2.09989200094-001		5.29298343462-008		1.60635777623-003	2.80340011712-002
1.99237526460-001				4.19919067973-004				1.99963811983-005		4.00371238560-001		1.34905042912-005	5.11109057450-001
2.45925058360+000													
1.90109375000-001				1.97767171175+000				1.76087362597-001		5.67418165091-008		1.09980195833-003	2.00968145025-002
2.13470708470-001				3.90119675890-004				2.14552006190-005		3.93253921125-001		1.03010683299-005	5.12917330789-001
2.46568605275+000													
2.18623761250-001				1.98446321976+000				1.45441142401-001		5.85265097130-008		7.32049294010-004	1.40426359820-002
2.26065809011-001				3.53418476123-004				2.24186738169-005		3.85955886158-001		7.50993885652-006	5.13908230056-001
2.47131700467+000													
2.51419648437-001				1.98948943162+000				1.18293678669-001		5.79679225541-008		4.71804546004-004	9.53882793463-003
2.42999550069-001				3.12292442764-004				2.28009910092-005		3.78488824470-001		5.21443089467-006	5.13779405588-001
2.47620996193+000													
2.89132595703-001				1.99311074522+000				9.47371072039-002		5.50742666895-008		2.92921424263-004	6.27731136016-003
2.58326301586-001				2.69261658816-004				2.25518944380-005		3.70025573260-001		3.43853154805-006	5.12263172552-001
2.48116659466+000													
3.32502485059-001				1.99564314200+000				7.47201037194-002		5.00463166594-008		1.74080685247-004	3.98478334998-003
2.74211005709-001				2.26651465676-004				2.16654382923-005		3.62883664426-001		2.14694406540-006	5.09102922854-001
2.48673821311+000													
3.82377857017-001				1.99735499331+000				5.80679993316-002		4.33694343903-008		9.82649043771-005	2.42693881620-003
2.90971176415-001				1.86411700640-004				2.01859456183-005		3.54504317820-001		1.26537793757-006	5.04013200597-001
2.49346159568+000													
4.39734536490-001				1.99646767981+000				4.45124451139-002		6.39703946548-010		5.21989171191-005	1.40900822756-003
3.09135189586-001				1.50020381537-004				1.82107043317-005		3.45423329855-001		7.02141190309-007	4.96620909717-001
2.50191768314+000													
5.05694710963-001				1.99915830145+000				3.37299049081-002		6.03316237790-010		2.58066486565-005	7.73829877727-004
3.29533606132-001				1.18489582262-004				1.58877886304-005		3.35225253040-001		3.66374735327-007	4.86375978230-001
2.51282436524+000													
3.81548924508-001				1.99956362223+000				2.53657745181-002		5.61056562232-010		1.17485805256-005	3.99074925940-004
3.53442083534-001				9.23976456376-005				1.34240480829-005		3.23272246209-001		1.80511361268-007	4.72430494386-001
2.52715868211+000													
6.68781265104-001				1.99978605777+000				1.91278722559-002		5.16260135634-010		4.89926299032-006	1.92941872908-004
3.82854641934-001				7.24133000591-005				1.11149236595-005		3.08567121571-001		8.58714186976-006	4.53383928740-001
2.54641823012+000													
7.69098452662-001				1.99980455165+000				1.49936858535-002		1.16981366334-008		1.96957249777-006	9.17425975343-005
4.20794796172-001				6.12809622201-005				9.69879027332-006		2.89597752519-001		4.44221615832-006	4.26944452774-001
2.57296183506+000													
8.84463228561-001				1.99995678852+000				1.17679901351-002		4.28324675814-010		5.95281876458-007	3.46516030963-005
4.77365274410-001				4.94629095690-005				7.36790726046-006		2.61303678841-001		5.51834809191-010	3.86086288981-001
2.61367046413+000													



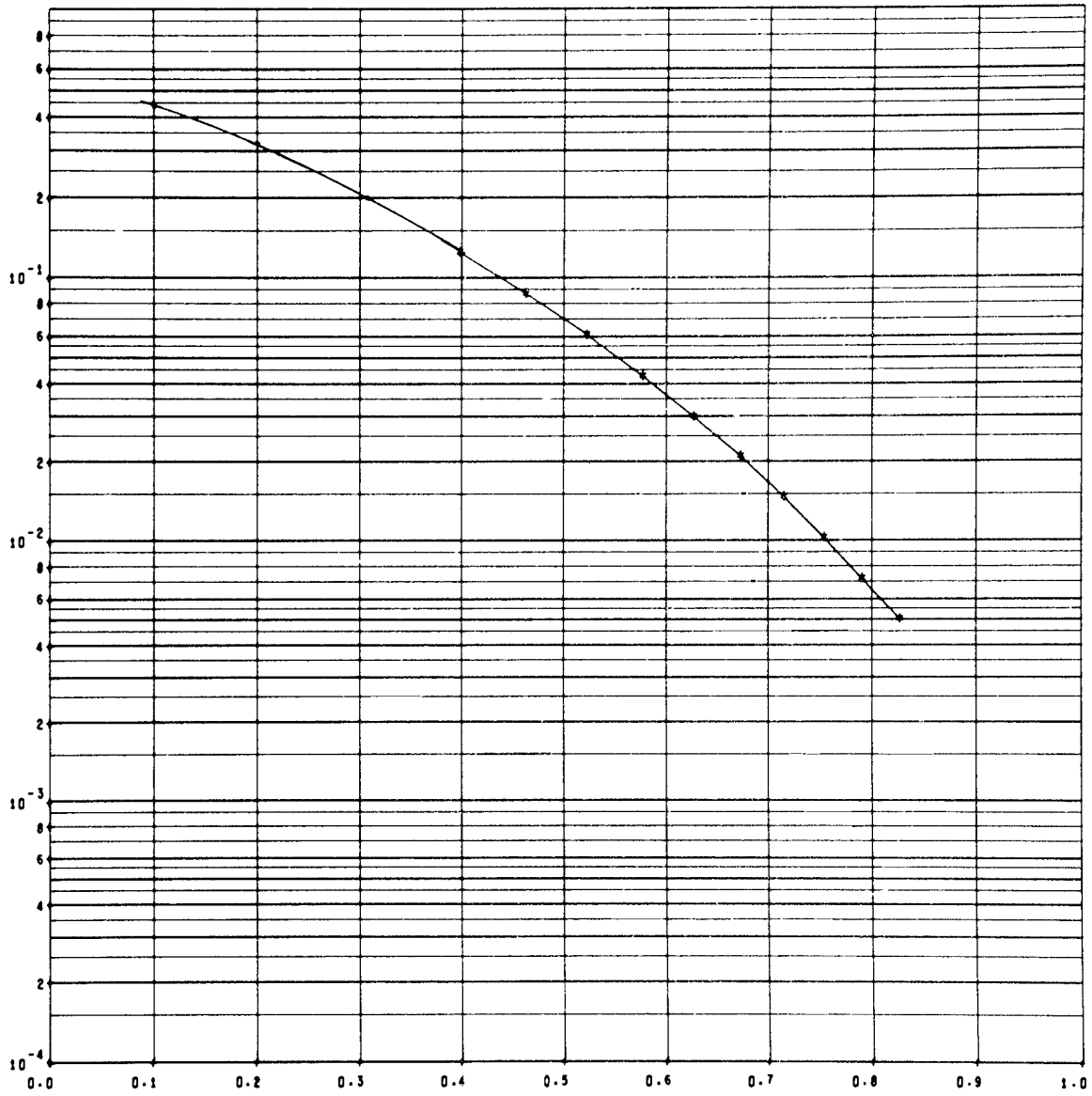
URETHANE FOAM

PRESSURE-VOLUME ISENTROPE



URE7HANE FOAM

TEMPERA7URE-VOLUME 1SEN7ROPE



URETHANE FOAM

PRESSURE-PARTICLE VELOCITY

APPENDIX B.

THE BKW HUGONIOT FOR 0.32-g/cc POLYURETHANE FOAM AND THE ISENTROPE THROUGH THE 90-kbar HUGONIOT VALUE

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 A FORTRAN BKW CALCULATION FOR
URETHANE FOAM

THE NUMBER OF ELEMENTS IS      4

THE NUMBER OF GAS SPECIES IS     11

THE NUMBER OF SOLID SPECIES IS      1

THE BKW EQUATION OF STATE PARAMETERS ARE
 ALPHA= 5.000000000000E-01 BETA= 1.600000000000E-01 THETA= 4.000000000000E+02 KAPPA= 1.090977844366+01

THE COMPOSITION
     3.000000000000E+00 MOLES OF   C
     7.000000000000E+00 MOLES OF   H
     1.000000000000E+00 MOLES OF   N
     2.000000000000E+00 MOLES OF   O

THE DENSITY                  IS  3.200000000000E-01, GRAMS/CC

THE MOLECULAR WEIGHT IS  8.909400000000E+01 GRAMS

THE HEAT OF FORMATION AT 0 DEG K IS -7.700000000000E+04 CALORIES PER FORMULA WEIGHT

THE SOLID (COWAN) EQUATION OF STATE PARAMETERS     VO, AS, BS, CS, DS, ES,      A1, A2, C1, C2, C3, ATOMIC WT

SOL C   4.444444444444E-01   8.309358372686-01  -1.393818092196+00   6.725697160216-01  -1.135372625086-01   6.491558820076-03
       -2.267053459486-01   1.205165695256-01   8.316000000006-02  -1.755900000006-01   1.553100000006-01   1.201000000006+01


THE INPUT              PRODUCT ELEMENTAL COMPOSITION MATRIX
  0          2.0E+00   0          1.0E+00   0          2.0E+00   0          0          0          0          0          2.0E+00
  1.0E+00    0         0          2.0E+00   1.0E+00    0         0          1.0E+00    0          3.0E+00    1.0E+00    0
  0          1.0E+00   0          0         0          0         1.0E+00    1.0E+00    0          0          2.0E+00    0
  0          1.0E+00   0          1.0E+00   1.0E+00    4.0E+00   0          0          1.0E+00    0          0          0


 THE BKW HUGONIOT FOR
URETHANE FOAM

PRESSURE =  5.000000000000E-01 VOLUME =  5.160799460846-01 TEMPERATURE =  9.077129956616+03
SHOCK VELOCITY =  1.368057035956+00 PARTICLE VELOCITY = 9.721292792236-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

 SPECIE    NO OF MOLES
H20       1.534273286536+00
H2        5.555107117946-01
O2        8.525750477426-04
CO2       1.738042042386-02
CO        4.082816928546-01
NH3       2.035453842866-01
H         8.392647300846-02
NO        1.602953702516-02
N2        3.902125393456-01
OH        4.949292647666-03
CH4       5.302300212106-01
SOL C     2.044107665516+00
```

PRESSURE = 4.500000000000E-01 VOLUME = 5.409178316O9E-01 TEMPERATURE = 8.838122225S4E+03
SHOCK VELOCITY = 1.304075201S3E+00 PARTICLE VELOCITY = 9.193734562I6E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	1.46575237619E+00
H2	5.54650893853E-01
O2	7.79171078048E-04
CO2	1.97905401700E-02
CO	4.72520211070E-01
NH3	2.02682728257E-01
H	7.96882838540E-02
NO	1.51232477406E-02
N2	3.91097012001E-01
OH	5.46474250233E-03
CH4	5.66498062196E-01
SOL C	1.94119118656E+00

PRESSURE = 4.000000000000E-01 VOLUME = 5.69964945277E-01 TEMPERATURE = 8.56732497353E+03
SHOCK VELOCITY = 1.2366276641E+00 PARTICLE VELOCITY = 8.63580692331E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	1.39053158057E+00
H2	5.59860108042E-01
O2	6.80093236748E-04
CO2	2.20935690717E-02
CO	5.44097652733E-01
NH3	2.01065786528E-01
H	7.56947697545E-02
NO	1.38782764858E-02
N2	3.92527968493E-01
OH	5.94516559953E-03
CH4	6.03594831962E-01
SOL C	1.83021394623E+00

PRESSURE = 3.500000000000E-01 VOLUME = 6.045143366I2E-01 TEMPERATURE = 8.254342981I0E+03
SHOCK VELOCITY = 1.16450486618E+00 PARTICLE VELOCITY = 8.041749013B9E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	1.30958390427E+00
H2	5.72662308564E-01
O2	5.58566875375E-04
CO2	2.41025396653E-02
CO	6.22496451322E-01
NH3	1.98387525474E-01
H	7.17239141724E-02
NO	1.22673358680E-02
N2	3.94672569329E-01
OH	6.33009546072E-03
CH4	6.40572747070E-01
SOL C	1.71282826194E+00

PRESSURE = 3.000000000000E-01 VOLUME = 6.46418994330E-01 TEMPERATURE = 7.88237646344E+03
SHOCK VELOCITY = 1.08719730359E+00 PARTICLE VELOCITY = 7.40389351754E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	1.22530829680E+00
H2	5.95241928823E-01
O2	4.21516711665E-04
CO2	2.56008446152E-02
CO	7.05850496222E-01
NH3	1.94194205328E-01
H	6.73288239221E-02
NO	1.02771842041E-02
N2	3.97764305234E-01
OH	6.51930011471E-03
CH4	6.75617202181E-01
SOL C	1.59293145698E+00

PRESSURE = 2.50000000000E-01 VOLUME = 6.98324946774E-01 TEMPERATURE = 7.42158724201E+03
SHOCK VELOCITY = 1.00302866502E+00 PARTICLE VELOCITY = 6.71187625594E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	1.14354734781E+00
H2	6.30548457151E-01
O2	2.80059082359E-04
CO2	2.63787146180E-02
CO	7.88872149095E-01
NH3	1.87798029419E-01
H	6.15458497261E-02
NO	7.91850775880E-03
N2	4.02141731411E-01
OH	6.34444794011E-03
CH4	7.05131001041E-01
SOL C	1.47961813525E+00

PRESSURE = 2.00000000000E-01 VOLUME = 7.63578482468E-01 TEMPERATURE = 6.81153866520E+03
SHOCK VELOCITY = 9.09446541314E-01 PARTICLE VELOCITY = 5.95204589170E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

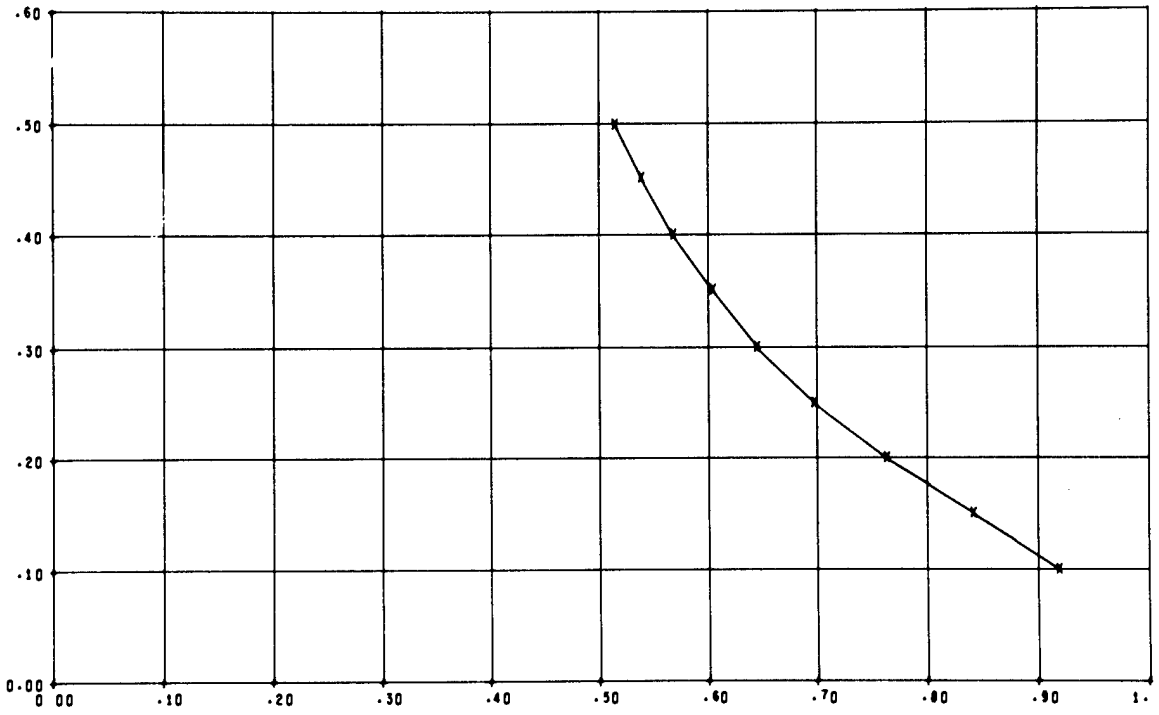
SPECIE	NO OF MOLES
H2O	1.08044606309E+00
H2	6.61208379191E-01
O2	1.49543898866E-04
CO2	2.63186659444E-02
CO	6.55849339785E-01
NH3	1.78094331451E-01
H	5.21763323829E-02
NO	5.24784545296E-03
N2	4.06328911548E-01
OH	5.51833198403E-03
CH4	7.21177364179E-01
SOL C	1.39665463009E+00

PRESSURE = 1.50000000000E-01 VOLUME = 8.42882015147E-01 TEMPERATURE = 5.90940100351E+03
SHOCK VELOCITY = 8.01170881993E-01 PARTICLE VELOCITY = 5.11045030628E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	1.09168755038E+00
H2	7.39145252265E-01
O2	4.94636119314E-05
CO2	2.55269198292E-02
CO	8.51103728805E-01
NH3	1.63061980291E-01
H	3.45605973322E-02
NO	2.45518908207E-03
N2	4.17241415313E-01
OH	3.60076484654E-03
CH4	7.02746772912E-01
SOL C	1.42062257845E+00

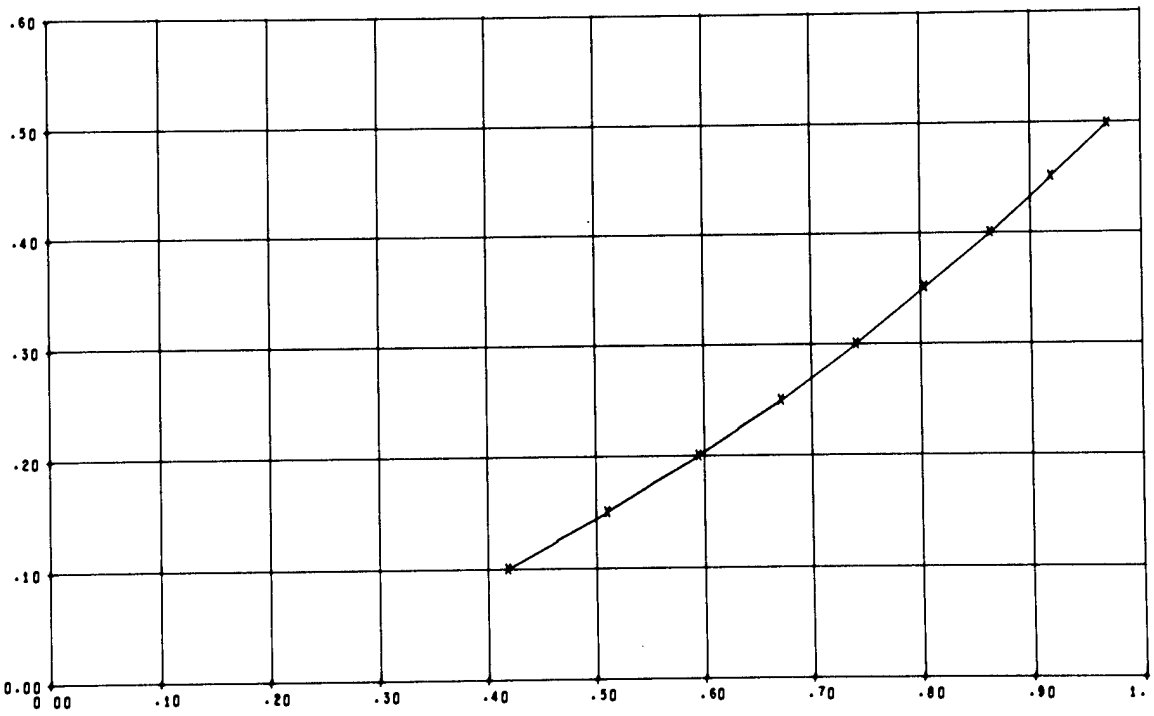
PRESSURE = 1.00000000000E-01 VOLUME = 9.19019094703E-01 TEMPERATURE = 4.45449978925E+03
SHOCK VELOCITY = 6.65345119785E-01 PARTICLE VELOCITY = 4.18073133474E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	1.35824775060E+00
H2	7.25592492042E-01
O2	3.68005035184E-06
CO2	2.29848617327E-02
CO	5.94502790395E-01
NH3	1.38448100079E-01
H	9.06956433824E-03
NO	3.79340271576E-04
N2	4.30586279825E-01
OH	8.93035164255E-04
CH4	6.01753153743E-01
SOL C	1.78075919413E+00



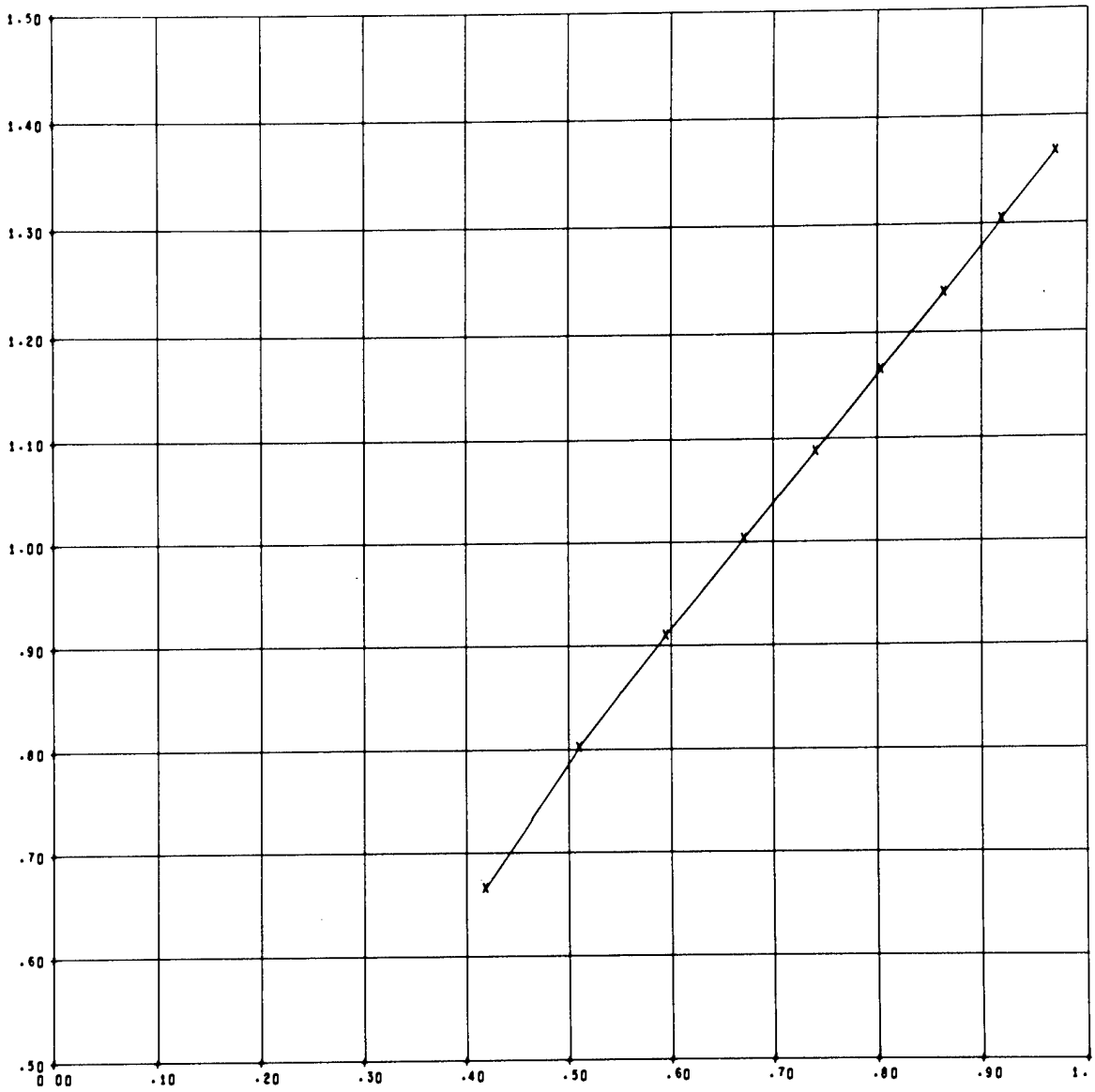
URETHANE FOAM

PRESSURE (MBARS) - VOLUME (CC/GM) HUGONIOT



URETHANE FOAM

PRESSURE (MBARS) - PARTICLE VELOCITY (CM/USEC) HUGONIOT



URETHANE FOAM

SHOCK VELOCITY - PARTICLE VELOCITY HUGONIOT

DISPLACED BKW ISENTROPE
URETHANE FOAM

LN(P)=-2.56519045884+000 -2.23728529604+000LNV 2.11284018320-001 LNV**2 6.26547703686-002LNV**3 -6.59273619193-002LNV**4

LN(T)= 8.28297349539+000 -5.79805143113-001LNV -7.90479270650-003 LNV**2 1.03337490284-001LNV**3 -2.43910588377-002LNV**4

LN(E)=-9.42099620781-001 4.17501397044-001LNP 8.04115394027-002 LNP**2 1.15042935475-002LNP**3 7.96660426551-004LNP**4

THE CONSTANT ADDED TO ENERGIES WAS 1.00000000000-001

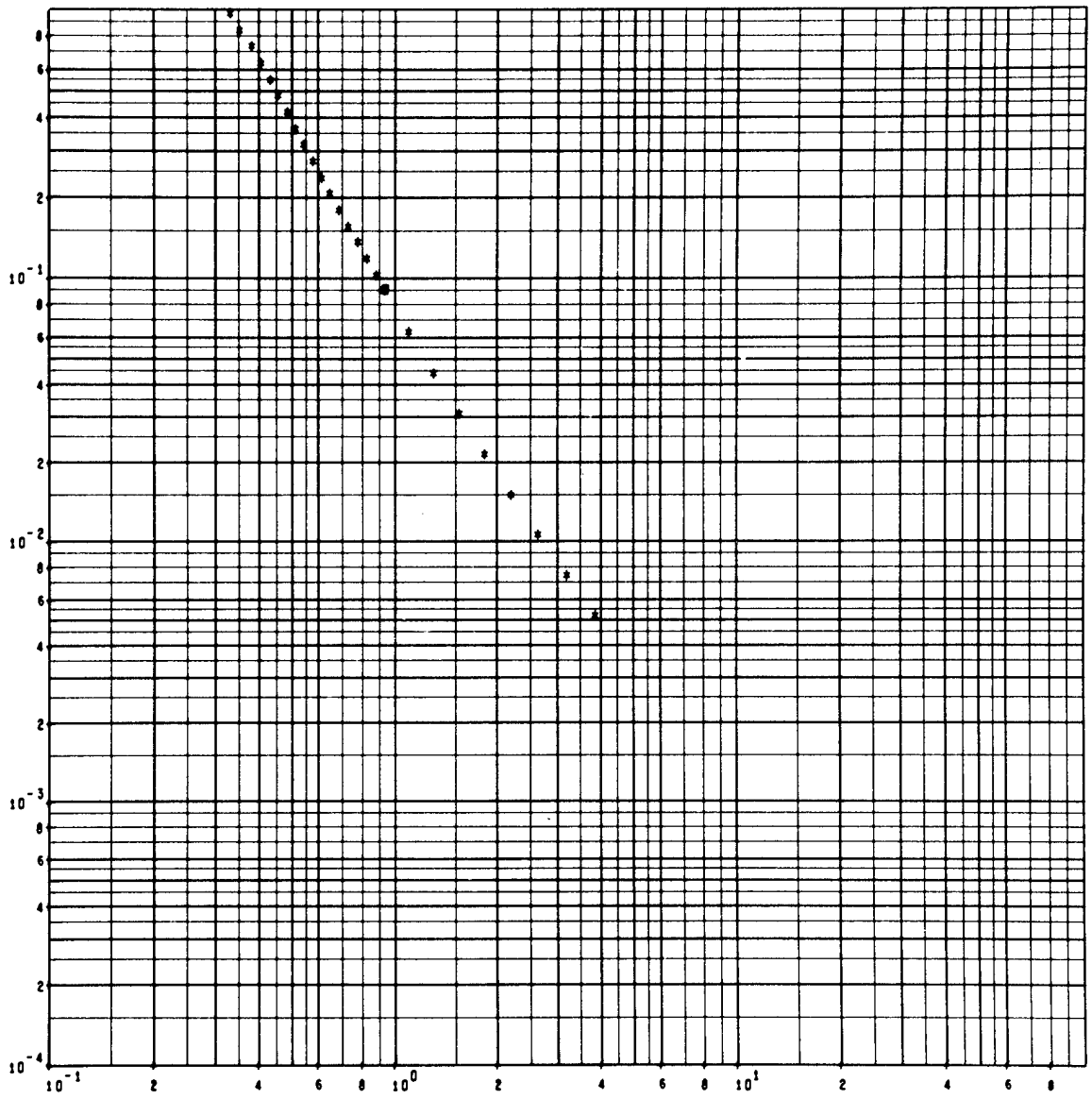
PRESSURE (MBARS)	VOLUME (CC/GM)	TEMPERATURE (DEG K)	ENERGY+C (MB-CC/GM)	GAMMA (-DLNP/DLNV)	PARTICLE VELOCITY
9.00000000000-002	9.33666544961-001	4.10680435258+003	1.98611080021-001	2.26531789716+000	4.44094596852-001
6.30000000000-002	1.09860226731+000	3.72632703915+003	1.86284105538-001	2.19610462763+000	5.11009750829-001
4.41000000000-002	1.29803814090+000	3.38544561369+003	1.75824623704-001	2.11894751626+000	5.72158250291-001
3.08700000000-002	1.53908371209+000	3.08514177173+003	1.66820122720-001	2.04127346090+000	6.27939659690-001
2.16090000000-002	1.83360519458+000	2.82832140470+003	1.59218957178-001	1.97075113240+000	6.79408210536-001
1.51263000000-002	2.19398940562+000	2.60764684409+003	1.52713725064-001	1.91714115615+000	7.27009057312-001
1.05884100000-002	2.63693561910+000	2.41769121459+003	1.47117801751-001	1.89123564665+000	7.71421385203-001
7.41188700000-003	3.18520551793+000	2.25333268811+003	1.42271111841-001	1.90550083934+000	8.13314656313-001
5.18832090000-003	3.86945669085+000	2.11010522043+003	1.38038464655-001	1.97467983907+000	8.53282351696-001
1.03500000000-001	8.77250482160-001	4.26669792752+003	2.04120367616-001	2.28880979693+000	0.00000000000+000
1.19025000000-001	8.24414030551-001	4.42680709974+003	2.09924197870-001	2.30997003637+000	0.00000000000+000
1.36878750000-001	7.75209495034-001	4.58802673403+003	2.16139792966-001	2.32834098742+000	0.00000000000+000
1.57410562500-001	7.29369474154-001	4.74842647839+003	2.22800846555-001	2.34363057061+000	0.00000000000+000
1.81022146875-001	6.86659293196-001	4.90595256954+003	2.29942988854-001	2.35556307932+000	0.00000000000+000
2.08175468906-001	6.47137391721-001	5.06455778869+003	2.37810480820-001	2.36384964367+000	0.00000000000+000
2.39401789242-001	6.10060464697-001	5.21172073801+003	2.46081900289-001	2.36838128987+000	0.00000000000+000
2.75312057629-001	5.75485328502-001	5.35041879814+003	2.54952463106-001	2.36890007437+000	0.00000000000+000
3.16608866273-001	5.43207614611-001	5.47969637745+003	2.64476819577-001	2.36522653174+000	0.00000000000+000
3.64100196214-001	5.13001212899-001	5.59927304103+003	2.74728785939-001	2.35717542411+000	0.00000000000+000
4.18715225646-001	4.84611937529-001	5.70956323271+003	2.85811396811-001	2.34451188464+000	0.00000000000+000
4.81522509493-001	4.57749441866-001	5.81165487570+003	2.97873324151-001	2.32680886092+000	0.00000000000+000
5.53750885917-001	4.32062200779-001	5.90733208338+003	3.11140279732-001	2.30368021247+000	0.00000000000+000
6.36813518804-001	4.07049016985-001	5.99944186829+003	3.26001027356-001	2.27375583965+000	0.00000000000+000
7.32335546625-001	3.81694167898-001	6.09387107678+003	3.43335687611-001	2.23430735259+000	0.00000000000+000
8.42185878618-001	3.53371609699-001	6.20807328488+003	3.65618577126-001	2.17662282892+000	0.00000000000+000
9.68513760411-001	3.30608399088-001	6.30526435089+003	3.86091332249-001	2.11715922725+000	0.00000000000+000

THE ISENTROPE STATE VARIABLES AS COMPUTED FROM THE LEAST SQUARE FIT

BKW PRESSURE	FIT PRESSURE	BKW TEMPERATURE	FIT TEMPERATURE	BKW ENERGY PLUS CONSTANT	FIT ENERGY
9.00000000000-002	8.97561523576-002	4.10680435258+003	4.11624971203+003	1.98611080021-001	1.98887685238-001
6.30000000000-002	6.24326763941-002	3.72632703915+003	3.74607346701+003	1.86284105538-001	1.86693349953-001
4.41000000000-002	4.35601889060-002	3.38544561369+003	3.40470101129+003	1.75824623704-001	1.76213872233-001
3.08700000000-002	3.05664291670-002	3.08514177173+003	3.09932740384+003	1.66820122720-001	1.67143789091-001
2.16090000000-002	2.15153700961-002	2.82832140470+003	2.83062700805+003	1.59218957178-001	1.59280383689-001
1.51263000000-002	1.51861619042-002	2.60764684409+003	2.60023711815+003	1.52713725064-001	1.52501330005-001
1.05884100000-002	1.07052783330-002	2.41769121459+003	2.40665994406+003	1.47117801751-001	1.46749297826-001
7.41188700000-003	7.48477526973-003	2.25333268811+003	2.24709412367+003	1.42271111841-001	1.42022010680-001
5.18832090000-003	5.13625397061-003	2.11010522043+003	2.11795289297+003	1.38038464655-001	1.38367169154-001
1.03500000000-001	1.03443899399-001	4.26669792752+003	4.26624485631+003	2.04120367616-001	2.04223973618-001
1.19025000000-001	1.19328412923-001	4.42680709974+003	4.41980661517+003	2.09924197870-001	2.09922592425-001
1.36878750000-001	1.37636128362-001	4.58802673403+003	4.57464210909+003	2.16139792966-001	2.16021648410-001
1.57410562500-001	1.58699761502-001	4.74842647839+003	4.72994416905+003	2.22800846555-001	2.22564646858-001
1.81022146875-001	1.82076471750-001	4.90595256954+003	4.88457950976+003	2.29942988854-001	2.29601243981-001
2.08175468906-001	2.10337021194-001	5.06455778869+003	5.03623037984+003	2.37810480820-001	2.37188132556-001
2.39401789242-001	2.41853516162-001	5.21172073801+003	5.18566335484+003	2.46081900289-001	2.45390087925-001
2.75312057629-001	2.77702096397-001	5.35041879814+003	5.33060957470+003	2.54952463106-001	2.54281207543-001
3.16608866273-001	3.18366002293-001	5.47969637745+003	5.46978469562+003	2.64476819577-001	2.63946384816-001
3.64100196214-001	3.64423121651-001	5.59927304103+003	5.60204269517+003	2.74728785939-001	2.74483067412-001
4.18715225646-001	4.16618655845-001	5.70956323271+003	5.72638025706+003	2.85811396811-001	2.86003362046-001
4.81522509493-001	4.75987725456-001	5.81165487570+003	5.84195526258+003	2.97873324151-001	2.98636562700-001
5.53750885917-001	5.44099262146-001	5.90733208338+003	5.94796063926+003	3.11140279732-001	3.12532198093-001
6.36813518804-001	6.23689415649-001	5.99944186829+003	6.04370151635+003	3.26001027356-001	3.27863718259-001
7.32335546625-001	7.21014420864-001	6.09387107678+003	6.12882360227+003	3.43335687611-001	3.44832970733-001
8.42185878618-001	8.54720223414-001	6.20807328488+003	6.20229144551+003	3.65618577126-001	3.63675656200-001
9.68513760411-001	9.86119281004-001	6.30526435089+003	6.23733606924+003	3.86091332249-001	3.84668004118-001

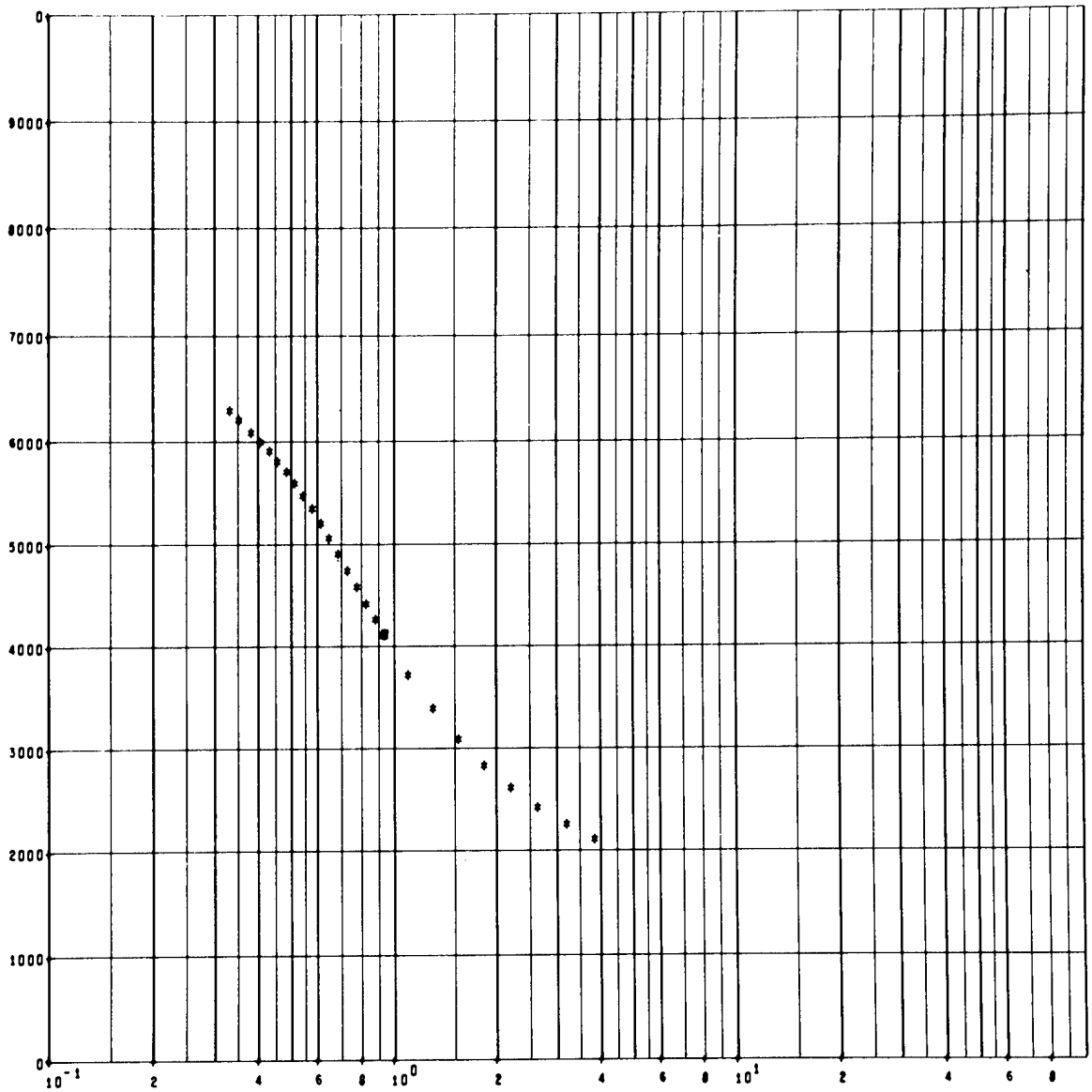
THE ISENTROPE PRESSURE AND COMPOSITION OF PRODUCTS

H2O	H2	O2	CO2	CO	NH3	H	NO	N2	OH	CH4	SOL C		
9.00000000000-002				1.45142739729+000				7.00361355369-001			1.48564210065-006	2.17494142642-002	5.04341142492-001
1.32127662930-001				5.51689841073-003				1.96950141335-004			4.33837663464-001	5.32710267299-004	5.73497459305-001
1.90041198394+000													
6.30000000000-002				1.30407887526+000				8.76216456824-001			4.70352937629-007	2.63691489211-002	6.42674268613-001
1.11305629366-001				4.25309262800-003				8.90524534466-005			4.44302659090-001	4.18565130433-004	5.75205197496-001
1.75575138497+000													
4.41000000000-002				1.16040125790+000				1.04362846475+000			1.29596992910-007	3.09446875330-002	7.77383309756-001
9.25465799317-002				2.95934149108-003				3.64407231567-005			4.53708489673-001	2.89357359173-004	5.77763029012-001
1.61390897370+000													
3.08700000000-002				1.02741235874+000				1.19292026678+000			6.23407244300-010	3.55664237469-002	9.01260218282-001
7.62899921861-007				1.89316611092-003				1.37975635021-005			4.61848105124-001	1.80776675460-004	5.82097707404-001
1.48107565057+000													
2.16090000000-002				9.04668128036-001				1.32460049358+000			4.27085537456-010	4.01919760745-002	1.01483667307+000
6.25558228127-002				1.15762571345-003				5.03013255555-006			4.68719573527-001	1.06215762178-004	5.88132861714-001
1.35683848915+000													
1.51263000000-002				7.97924135996-001				1.43569700552+000			2.66770949340-010	4.48650862990-002	1.11228447125+000
5.11811053886-002				6.82408665121-004				1.78708155076-006			4.74408553765-001	5.94325443539-005	5.94618139892-001
1.24823230256+000													
1.05884100000-002				7.08696699378-001				1.52689344864+000			1.45838596984-010	4.97078743511-002	1.19165477715+000
4.18897361448-002				3.92251234144-004				6.27749448468-007			4.79054818053-001	3.21467317573-005	6.00581524392-001
1.15805582411+000													
7.41188700000-003				6.37568085920-001				1.60002899536+000			6.45486221511-011	5.49228392199-002	1.25256901606+000
3.43706751355-002				2.21544699807-004				2.20264035799-007			4.82814552300-001	1.69991830770-005	6.05363817039-001
1.08714432768+000													
5.18832090000-003				5.82725966073-001				1.65753881136+000			2.02627171169-011	6.07655277714-002	1.29573404127+000
2.83168728493-002				1.23560094664-004				7.76980044935-008			4.85841524726-001	8.85937561608-006	6.08596851778-001
1.03490357916+000													
1.03500000000-001				1.50784637321+000				6.32284234057-001			2.23457856267-006	1.99287323143-002	4.51467791691-001
1.40673048816-001				5.93073734554-003				2.60869521189-004			4.29533040831-001	5.63031788556-004	5.72806467469-001
1.95579700653+000													
1.19025000000-001				1.56555571414+000				5.64471956417-001			3.22417725570-006	1.80275257121-002	3.97473415393-001
1.49350174725-001				6.20010717489-003				3.35533303584-004			4.25157145986-001	5.73837380253-004	5.71280047537-001
2.01321901136+000													
1.36878750000-001				1.62255452906+000				4.98701819157-001			4.47562116890-006	1.60683151907-002	3.44314736417-001
1.58107074534-001				6.32605097530-003				4.20187856346-004			4.20736366805-001	5.64965038630-004	5.69068765986-001
2.07054818241+000													
1.57410562500-001				1.67629150661+000				4.35772421784-001			5.94720140921-006	1.40507782765-002	2.92549414884-001
1.66916374067-001				6.28842132828-003				5.10741726175-004			4.16286442093-001	5.34885822973-004	5.66074928449-001
2.12732487839+000													
1.81022146875-001				1.73199002319+000				3.76410981134-001			7.52560203541-006	1.19921351389-002	2.42925300252-001
1.75786643566-001				6.08064031721-003				6.00706467526-004			4.11806224983-001	4.84648607420-004	5.62318042931-001
2.18276452168+000													
2.08175468906-001				1.78097290173+000				3.22036285605-001			9.16391278097-006	1.00035099943-002	1.97889295399-001
1.84716283995-001				5.76435743036-003				6.88968613558-004			4.07297373696-001	4.23486442533-004	5.58411232368-001
2.23369596224+000													
2.39401789242-001				1.82751139145+000				2.71495848486-001			1.03943892852-005	8.00871632185-003	1.55349243937-001
1.93895512007-001				5.26284873535-003				7.53830909877-004			4.02675328541-001	3.47312276903-004	5.53672205771-001
2.28296963397+000													
2.75312057629-001				1.86894843700+000				2.25837766293-001			1.10676404814-005	6.14445461174-003	1.17680274833-001
2.03453833920-001				4.65727066729-003				7.91594671586-004			3.97877265704-001	2.68648593826-004	5.48785043099-001
2.52739022746+000													
3.16608666273-001				1.90436381149+000				1.85234057630-001			1.10307000081-005	4.48905516060-003	8.56442243333-002
2.13596253258-001				3.99316459623-003				7.96590723123-004			3.92802578009-001	1.95201728020-004	5.43955283913-001
2.36591143659+000													
3.64100196214-001				1.93325120163+000				1.49714119760-001			1.02734693852-005	3.10389037254-003	5.96200402112-002
2.24560501173-001				3.31738614606-003				7.67637027287-004			3.87325930900-001	1.32793443195-004	5.39219418526-001
2.39605665089+000													
4.18715225646-001				1.95564392908+000				1.19207105471-001			8.93450657379-006	2.01751503984-003	3.95106245713-002
2.36713369763-001				2.67239287583-003				7.08203162151-004			3.81289213527-001	8.43440943429-005	5.34350271145-001
2.42412158924+000													
4.81522509493-001				1.97206973320+000				9.35098587288-002			7.25542049007-006	1.22382231810-003	2.47925837176-002
2.50424636903-001				2.09014162858-003				6.25615004657-004			3.74474774046-001	4.99126037652-005	5.28856562802-001
2.44512703116+000													
5.53750885917-001				1.98343365947+000				7.23475378322-002			5.49998194502-006	6.86012099274-004	1.46267096799-002
2.66363664713-001				1.59118381759-003				5.29132850271-004			3.66553601218-001	2.74738332956-005	5.21931988399-001
2.46275528982+000													
6.36813518804-001				1.99080908133+000				5.53562334896-002			3.89192100231-006	3.50856454747-004	8.03887728760-003
2.85597368010-001				1.18409082528-003				4.28478692142-004			3.56987076649-001	1.40659360306-005	5.12419777391-001
2.47919048887+000													
7.32355546625-001				1.99526320766+000				4.21662891911-002			2.58057783535-006	1.61107225434-004	4.06972016023-003
3.10027061277-001				8.69651156469-004				3.32954357238-004			3.44819992183-001	6.74219822346-006	4.98545857269-001
2.49722331534+000													
8.42185878618-001				1.99773018218+000				3.26056323830-002			1.64426866688-006	6.53849469068-005	1.88052546006-003
3.43594414339-001				6.49129302608-004				2.52180174866-004			3.28076702743-001	3.13374946589-006	4.76973256199-001
2.52108083339+000													
9.68513760411-001				1.99906753277+000				2.52080583249-002			8.93198773377-007	2.07764195221-005	7.16218412904-004
3.92640071114-001				4.66323549761-004				1.71636428642-004			3.03594146229-001	1.27315287425-006	4.43264751942-001
2.55599825323+000													



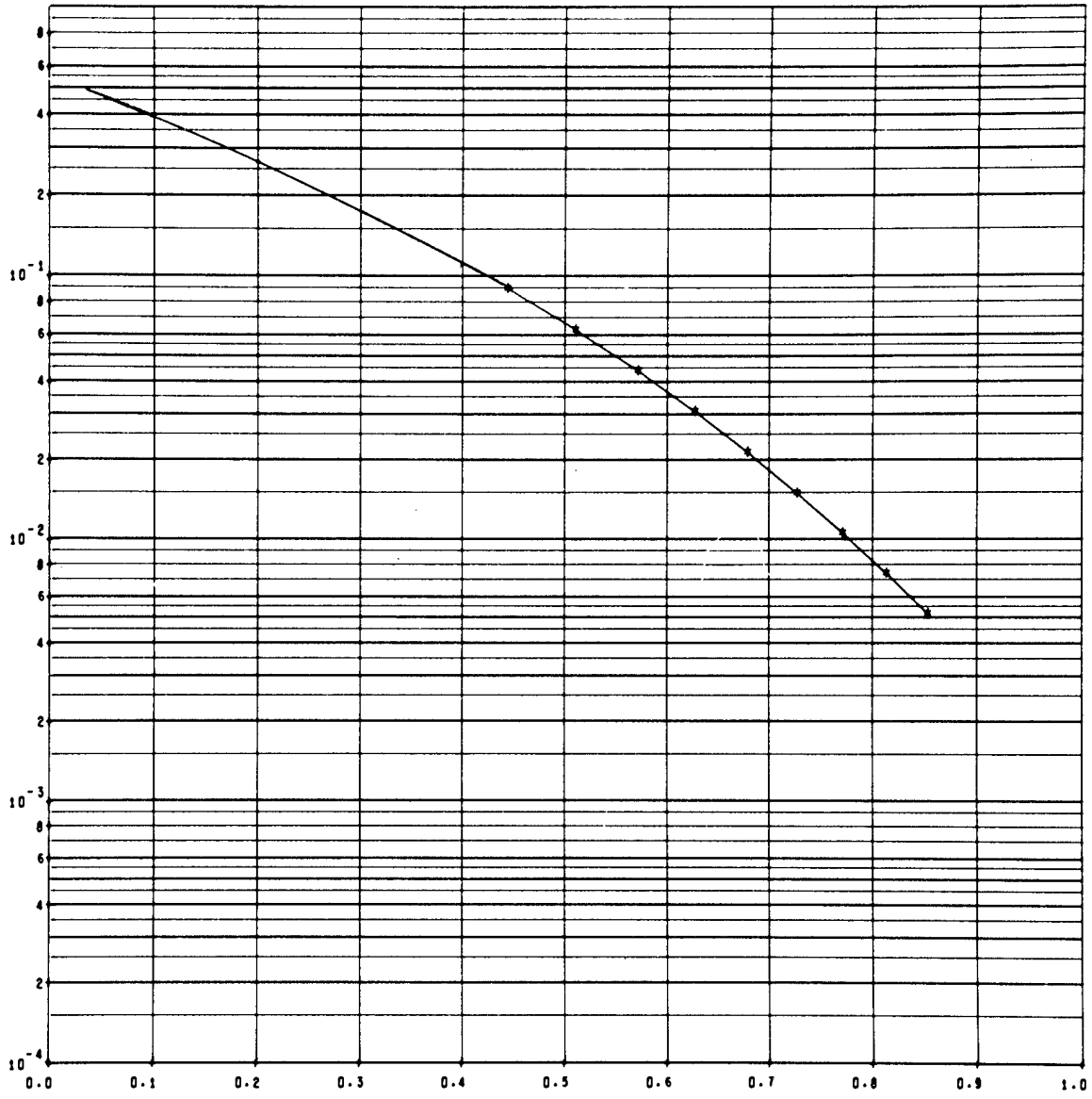
URETHANE FOAM

PRESSURE-VOLUME ISENTROPE



URETHANE FOAM

TEMPERATURE-VOLUME ISENTROPE



URETHANE FOAM

PRESSURE-PARTICLE VELOCITY

APPENDIX C.

THE BKW HUGONIOT AND ISENTROPE FOR A 0.5-g/cc FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

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 A FORTRAN BKW CALCULATION FOR
FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

THE NUMBER OF ELEMENTS IS      4

THE NUMBER OF GAS SPECIES IS    11

THE NUMBER OF SOLID SPECIES IS     1

THE BKW EQUATION OF STATE PARAMETERS ARE
 ALPHA= 5.000000000000E-01 BETA= 1.600000000000E-01 THETA= 4.000000000000E+02 KAPPA= 1.090977844366+01

THE COMPOSITION
     1.250000000000E+01 MOLES OF   C
     1.787000000000E+01 MOLES OF   H
     1.000000000000E+00 MOLES OF   N
     4.938000000000E+00 MOLES OF   O

THE DENSITY                  IS  5.000000000000E-01, GRAMS/CC

THE MOLECULAR WEIGHT IS  2.611539600006+02 GRAMS

THE HEAT OF FORMATION AT 0 DEG K IS -2.250000000000E+05 CALORIES PER FORMULA WEIGHT

THE SOLID (COMAN) EQUATION OF STATE PARAMETERS    VO, AS, BS, CS, OS, ES,     A1, A2, C1, C2, C3. ATOMIC WT

SOL C   4.444444444444E-01   8.309358372686-01  -1.393818092196+00   6.725697160216-01  -1.135372625086-01   6.491558820076-03
       -2.267053459486-01   1.205165695256-01   8.316000000000E-02  -1.755900000006-01   1.553100000006-01   1.201000000006+01

THE INPUT            PRODUCT ELEMENTAL COMPOSITION MATRIX
  0         2.0E+00   0         1.0E+00   0         2.0E+00   0         0         0         0         0         2.0E+00
  1.0E+00   0         0         2.0E+00   1.0E+00   0         0         1.0E+00   0         3.0E+00   1.0E+00   0
  0         1.0E+00   0         0         0         0         1.0E+00   1.0E+00   0         0         2.0E+00   0
  0         1.0E+00   0         1.0E+00   1.0E+00   4.0E+00   0         0         1.0E+00   0         0         0


 THE BKW HUGONIOT FOR
FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

PRESSURE =  5.000000000006-01 VOLUME =  4.470812769316-01 TEMPERATURE =  7.975166457026+03
SHOCK VELOCITY =  1.134854542806+00 PARTICLE VELOCITY = 8.811684337386-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND


 SPECIE   NO OF MOLES
H2O      4.381078313126+00
H2       6.647566072936-01
OH       6.951368186186-04
CO2      2.505205374896-02
CO       4.912834725226-01
NH3      3.572320859386-01
H        5.757455189396-02
NO       1.052746456726-02
N2       3.161202147476-01
OH       3.616348659396-03
CH4      1.661360750206+00
SOL C    1.032230372356+01
```

PRESSURE = 4.50000000000E-01 VOLUME = 4.66369144144E-01 TEMPERATURE = 7.70969208749E+03
SHOCK VELOCITY = 1.08336637274E+00 PARTICLE VELOCITY = 8.30742048716E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	4.30081117776E+00
H2	6.91384158144E-01
O2	6.14871514100E-04
CO2	2.87174378210E-02
CO	5.64907675476E-01
NH3	3.49777059863E-01
H	5.55772468308E-02
NO	9.68866893295E-03
N2	3.20267135602E-01
OH	3.92785916176E-03
CH4	1.69419326065E+00
SOL C	1.02121816260E+01

PRESSURE = 4.00000000000E-01 VOLUME = 4.88118886317E-01 TEMPERATURE = 7.40161553994E+03
SHOCK VELOCITY = 1.02872815836E+00 PARTICLE VELOCITY = 7.77657336873E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	4.21989771902E+00
H2	7.26441556612E-01
O2	5.07755922757E-04
CO2	3.21636875141E-02
CO	6.40100000185E-01
NH3	3.41995447686E-01
H	5.28527830654E-02
NO	8.52503348163E-03
N2	3.24739759416E-01
OH	4.13436044247E-03
CH4	1.72358699054E+00
SOL C	1.01041493218E+01

PRESSURE = 3.50000000000E-01 VOLUME = 5.12804040589E-01 TEMPERATURE = 7.03338925403E+03
SHOCK VELOCITY = 9.70240276412E-01 PARTICLE VELOCITY = 7.21468709369E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	4.14859179308E+00
H2	7.71303576204E-01
O2	3.78508592844E-04
CO2	3.48667257823E-02
CO	7.07782108482E-01
NH3	3.33456998813E-01
H	4.88076137782E-02
NO	7.00763904265E-03
N2	3.29767681072E-01
OH	4.12799064353E-03
CH4	1.74422566514E+00
SOL C	1.00131255006E+01

PRESSURE = 3.00000000000E-01 VOLUME = 5.40768942401E-01 TEMPERATURE = 6.57481868234E+03
SHOCK VELOCITY = 9.06834150754E-01 PARTICLE VELOCITY = 6.61640278436E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	4.10910023045E+00
H2	8.26089983051E-01
O2	2.38586047830E-04
CO2	3.59154426688E-02
CO	7.47707866340E-01
NH3	3.23535228788E-01
H	4.24131967836E-02
NO	5.14141135421E-03
N2	3.35661679929E-01
OH	3.74241442727E-03
CH4	1.74571456866E+00
SOL C	9.97066210213E+00

PRESSURE = 2.500000000000E-01 VOLUME = 5.71680950321E-01 TEMPERATURE = 5.97081706192E+03
SHOCK VELOCITY = 6.36752267224E-01 PARTICLE VELOCITY = 5.97560318378E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	4.14879871950E+00
H2	8.8402609304E-03
O2	1.09606109592E-04
CO2	3.36447690853E-02
CO	7.15870242230E-01
NH3	3.11447750700E-01
H	3.21129631732E-02
NO	3.03334095743E-03
N2	3.42759446032E-01
OH	2.78093679539E-03
CH4	1.70837621088E+00
SOL C	1.00420907778E+01

PRESSURE = 2.000000000000E-01 VOLUME = 6.03531175224E-01 TEMPERATURE = 5.12891354549E+03
SHOCK VELOCITY = 7.56802100718E-01 PARTICLE VELOCITY = 5.28481190286E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

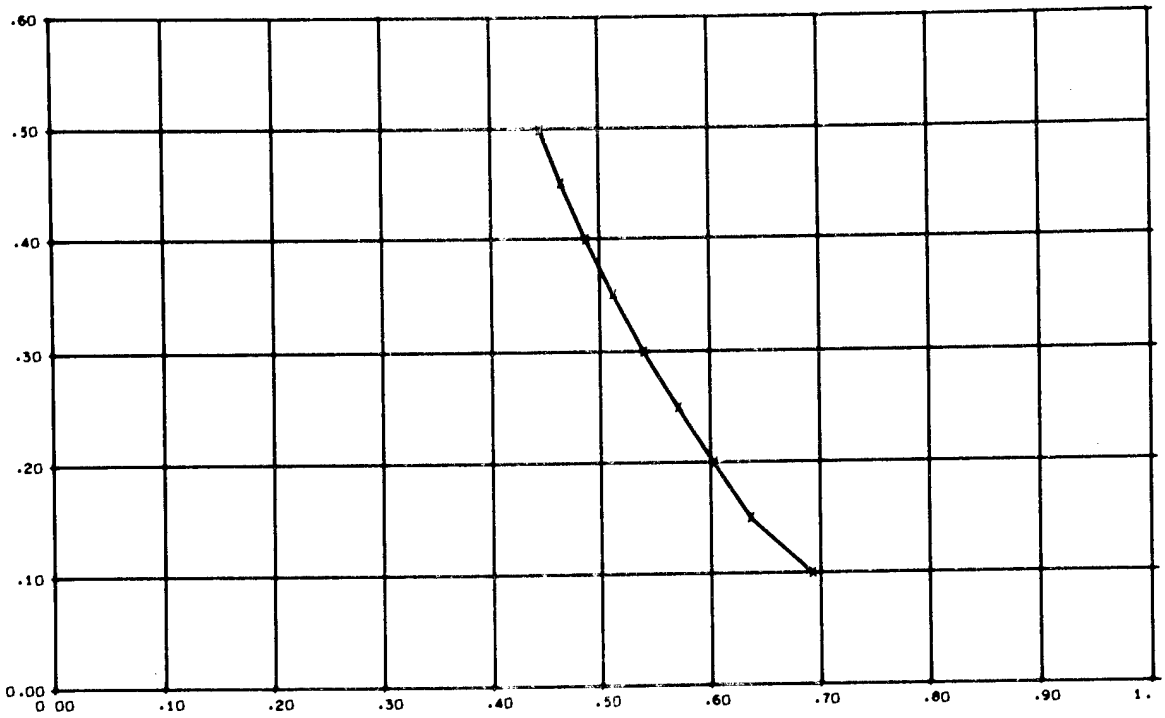
SPECIE	NO OF MOLES
H2O	4.34774293812E+00
H2	9.18745157935E-01
O2	2.48267194213E-05
CO2	2.53452203770E-02
CO	5.37124994594E-01
NH3	2.97338694245E-01
H	1.72199153766E-02
NO	1.09469257658E-03
N2	3.50783306589E-01
OH	1.29720051494E-03
CH4	1.60662263231E+00
SOL C	1.03309071527E+01

PRESSURE = 1.500000000000E-01 VOLUME = 6.37038051785E-01 TEMPERATURE = 4.01162577853E+03
SHOCK VELOCITY = 6.63486938052E-01 PARTICLE VELOCITY = 4.52153636703E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	4.68001662138E+00
H2	8.54413655745E-01
O2	1.14329042767C-06
CO2	1.19903144745E-02
CO	2.33651787193E-01
NH3	2.87460421108E-01
H	4.08799394703E-03
NO	1.30388854739E-04
N2	3.56204395020E-01
OH	2.18267039263E-04
CH4	1.48361297536E+00
SOL C	1.07707449250E+01

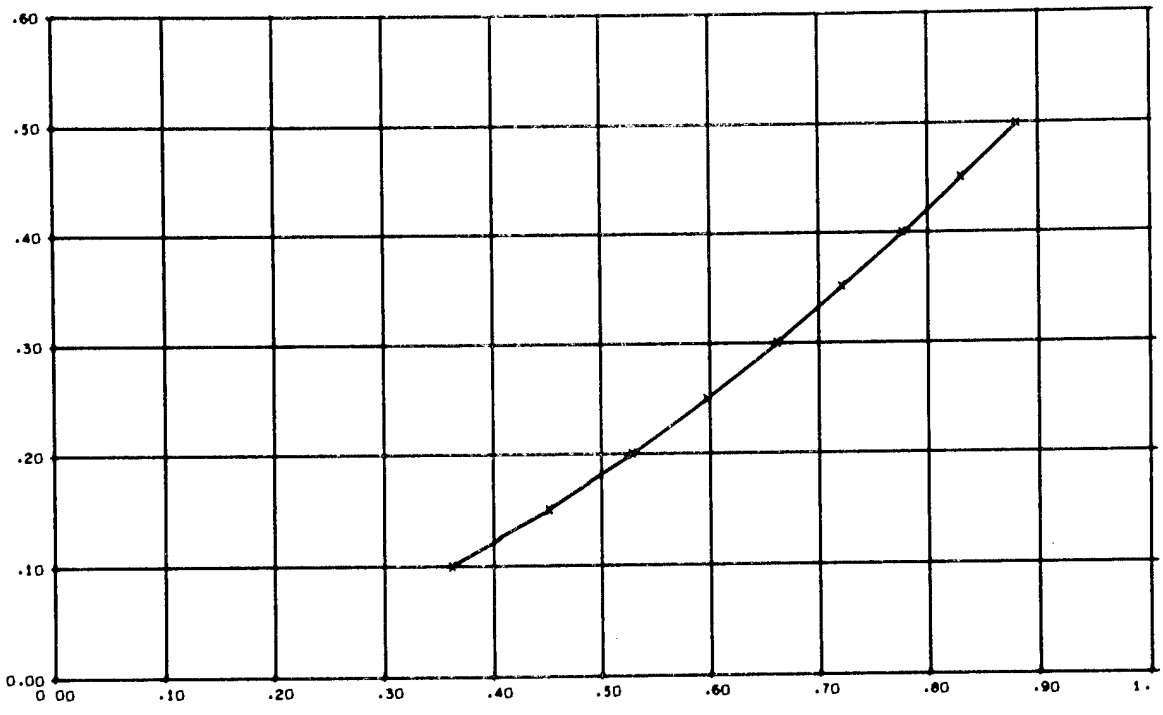
PRESSURE = 1.000000000000E-01 VOLUME = 6.92286692494E-01 TEMPERATURE = 2.86693639096E+03
SHOCK VELOCITY = 5.53059112734E-01 PARTICLE VELOCITY = 3.61621380780E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	4.87499508727E+00
H2	6.64201887364E-01
O2	3.68380779150E-10
CO2	4.00656739268E-03
CO	5.49789528405E-02
NH3	2.82922314573E-01
H	2.60036214675E-04
NO	2.77488996568E-06
N2	3.58537455368E-01
OH	9.23967809944E-06
CH4	1.48364205278E+00
SOL C	1.09553724270E+01



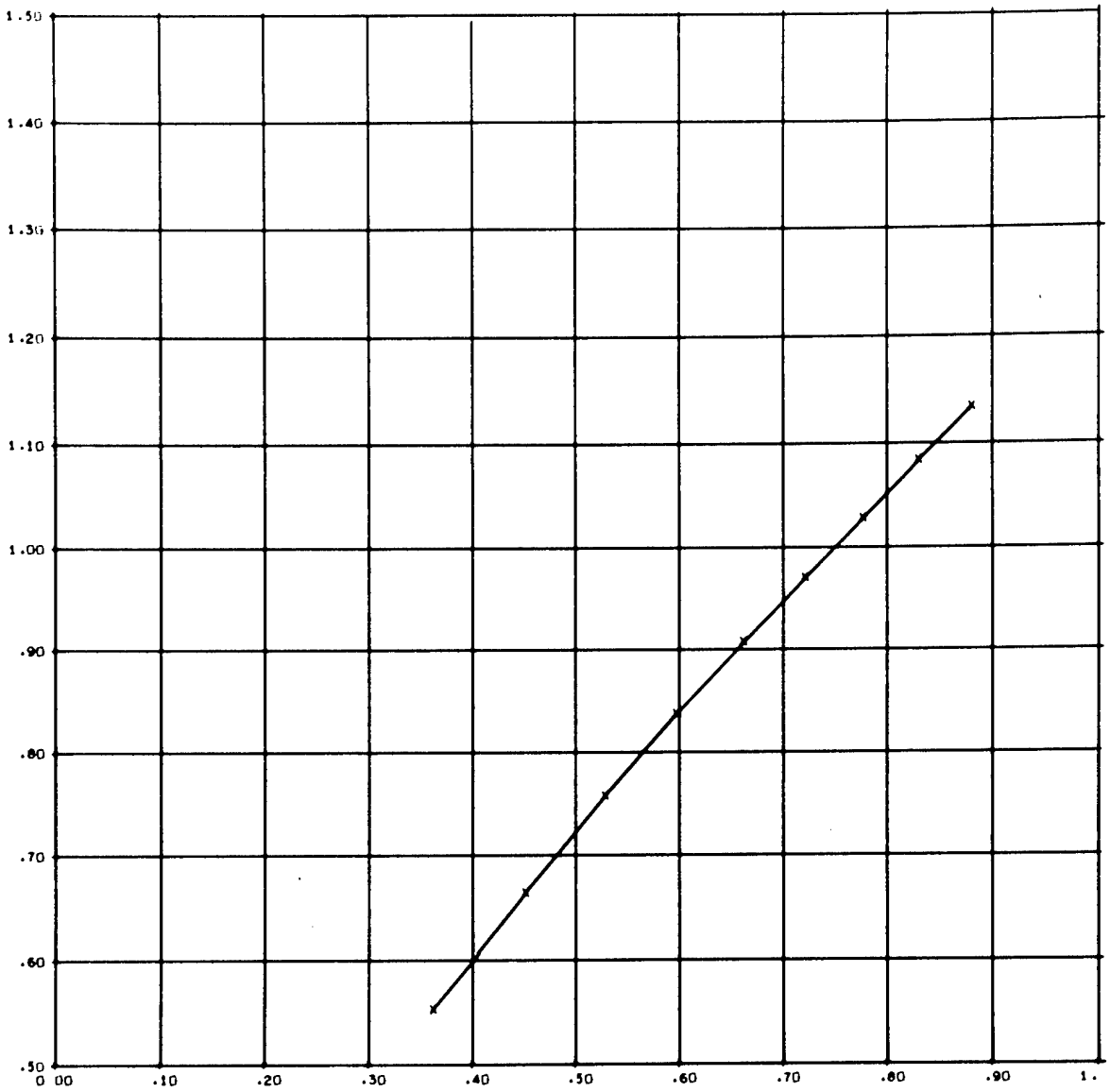
FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

PRESSURE (MBARS) - VOLUME (CC/GM) HUGONIOT



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

PRESSURE (MBARS) - PARTICLE VELOCITY (CM/USEC) HUGONIOT



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

SHOCK VELOCITY - PARTICLE VELOCITY HUGONIOT

A BKW ISENTROPE
FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

LN(P) = -3.16144428695E+00 -2.42600694085E+00LNV 5.98203344483E-01LNV**2 7.85262788982E-02LNV**3 -2.91761898223E-01LNV**4

LN(T) = 7.94137892242E+00 -4.63221344616E-01LNV 3.16786863094E-02LNV**2 4.60226860978E-02LNV**3 2.85424562172E-03LNV**4

LN(E) = -1.08005438787E+00 5.31563018694E-01LNP -1.67926393310E-01LNP**2 3.09878680288E-02LNP**3 2.25379939101E-03LNP**4

THE CONSTANT ADDED TO ENERGIES WAS 1.00000000000E-01

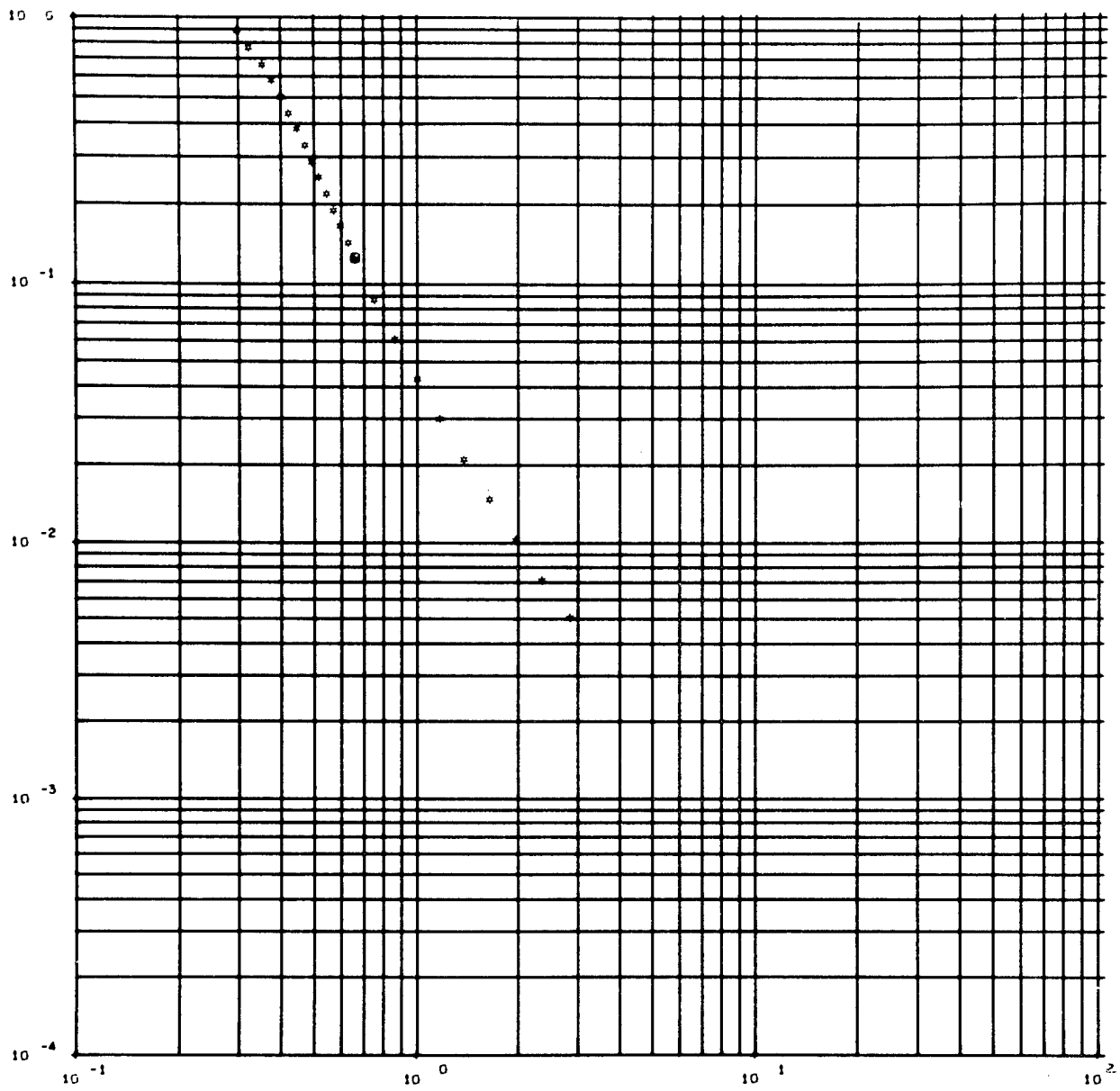
PRESSURE (MBARS)	VOLUME (CC/GM)	TEMPERATURE (DEG K)	ENERGY+C (MB-CC/GM)	GAMMA (-DLNP/DLNV)	PARTICLE VELOCITY
1.25000000000E-01	6.59921629181E-01	3.42329144535E+03	1.83755566313E-01	2.79878198288E+00	4.09279594948E-01
8.75000000000E-02	7.52262478503E-01	3.21458444237E+03	1.74099555596E-01	2.72057501581E+00	4.68773120473E-01
6.12500000000E-02	8.64165203104E-01	3.00612081973E+03	1.65956841475E-01	2.59201956936E+00	5.23827853601E-01
4.28750000000E-02	1.00126227713E+00	2.80010696018E+03	1.58896030900E-01	2.42449732384E+00	5.74532302518E-01
3.00125000000E-02	1.17065746620E+00	2.60629802347E+03	1.52825618292E-01	2.23621110810E+00	6.21089470119E-01
2.10087500000E-02	1.37984155808E+00	2.42838385235E+03	1.47578405847E-01	2.05533242609E+00	6.63621658609E-01
1.47061250000E-02	1.63814681317E+00	2.26843691575E+03	1.43043222980E-01	1.91843427147E+00	7.02671496010E-01
1.02942875000E-02	1.95770800758E+00	2.12639398572E+03	1.39116375088E-01	1.86978022533E+00	7.39147471518E-01
7.20600125000E-03	2.35485080152E+00	2.00092904488E+03	1.35701047532E-01	1.96172528964E+00	7.74198211857E-01
5.04420087500E-03	2.85186949127E+00	1.89014530201E+03	1.32709648671E-01	2.25667926322E+00	8.08924169139E-01
1.43750000000E-01	6.27874580221E-01	3.50433951258E+03	1.88049928575E-01	2.81414871759E+00	0.
1.65312500000E-01	5.97740435854E-01	3.58512078780E+03	1.92695481352E-01	2.82025650719E+00	0.
1.90109375000E-01	5.69277107286E-01	3.66575331809E+03	1.97742027810E-01	2.81657931144E+00	0.
2.18625781250E-01	5.42266879973E-01	3.74645639979E+03	2.03249717972E-01	2.80246267212E+00	0.
2.51419648437E-01	5.16509913410E-01	3.82750584816E+03	2.09290178985E-01	2.77707190501E+00	0.
2.89132595703E-01	4.91818286466E-01	3.90924874821E+03	2.15950010698E-01	2.73932059266E+00	0.
3.32502485059E-01	4.68007779743E-01	3.99213229185E+03	2.23336096840E-01	2.68776210795E+00	0.
3.82377857817E-01	4.44885509046E-01	4.07679464760E+03	2.31585424674E-01	2.62040757325E+00	0.
4.39734536490E-01	4.22226599268E-01	4.16422168530E+03	2.40883230548E-01	2.53437929669E+00	0.
5.05694716963E-01	3.99742663037E-01	4.25835524569E+03	2.51556930922E-01	2.42525464327E+00	0.
5.81548924508E-01	3.76855154658E-01	4.35800480741E+03	2.63972102081E-01	2.28454687467E+00	0.
6.68781263184E-01	3.52257375292E-01	4.47600402539E+03	2.79335749795E-01	2.09220082449E+00	0.
7.69098452662E-01	3.21249244783E-01	4.65526345740E+03	3.01633345836E-01	1.77199666606E+00	0.
8.84463220561E-01	2.98484820251E-01	4.80552657554E+03	3.20222250685E-01	1.46558472952E+00	0.

THE ISENTROPE STATE VARIABLES AS COMPUTED FROM THE LEAST SQUARES FIT

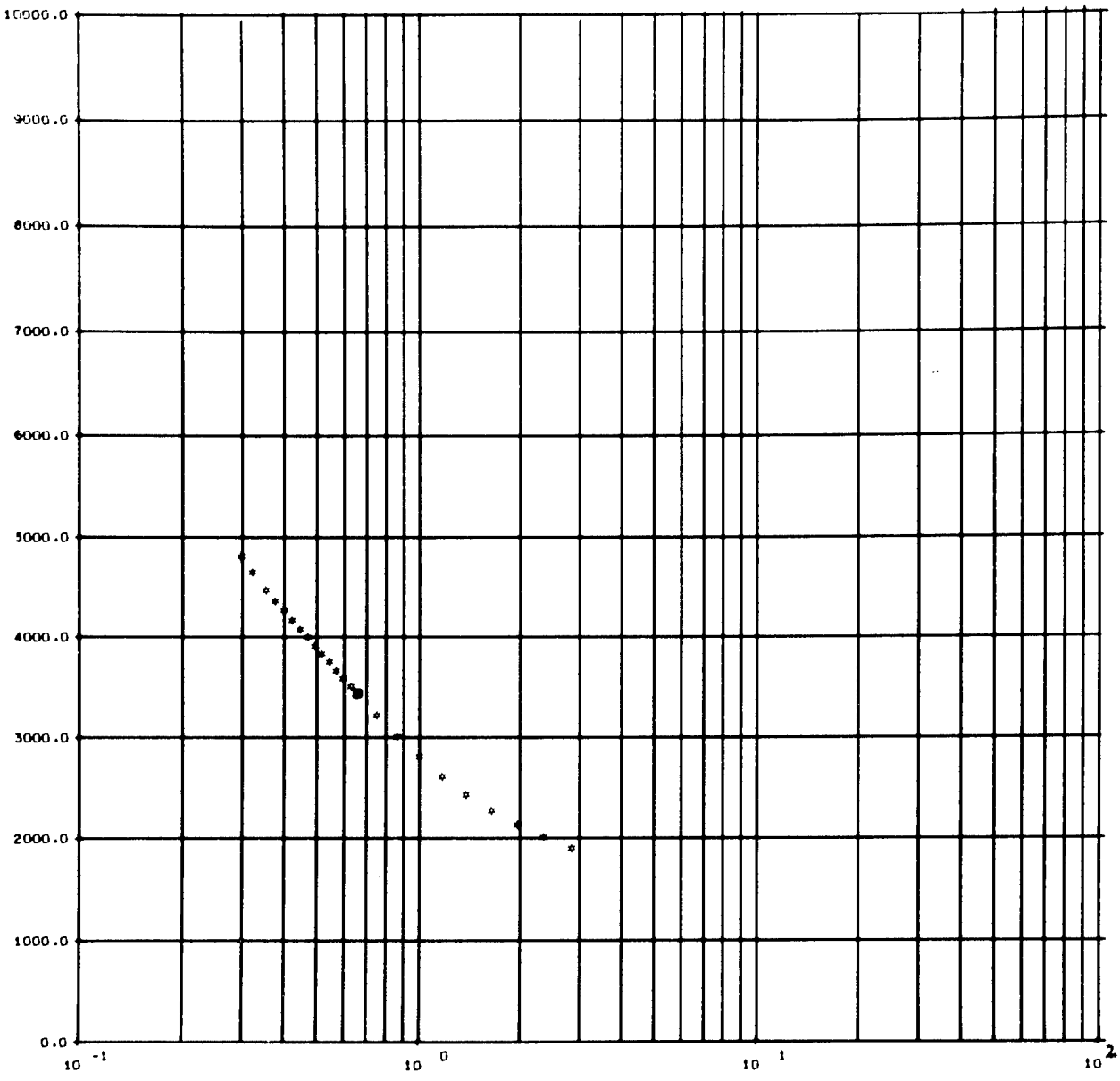
BKW PRESSURE	FIT PRESSURE	BKW TEMPERATURE	FIT TEMPERATURE	BKW ENERGY + C	FIT ENERGY
1.25000000000E-01	1.26930249250E-01	3.42329144535E+03	3.41578557497E+03	1.83755566313E-01	1.83457224871E-01
8.75000000000E-02	8.83822755186E-02	3.21458444237E+03	3.21238307748E+03	1.74099555596E-01	1.74288043496E-01
6.12500000000E-02	6.11212660777E-02	3.00612081973E+03	3.00952787828E+03	1.65956841475E-01	1.66506400890E-01
4.28750000000E-02	4.22350980261E-02	2.80010696018E+03	2.80959220195E+03	1.58896030900E-01	1.59642216228E-01
3.00125000000E-02	2.93424352659E-02	2.60629802347E+03	2.61588951195E+03	1.52825618292E-01	1.53433835549E-01
2.10087500000E-02	2.06292587331E-02	2.42838385235E+03	2.43350246072E+03	1.47578405847E-01	1.47786378525E-01
1.47061250000E-02	1.46841867695E-02	2.26843691575E+03	2.26690085540E+03	1.43043222980E-01	1.42741753536E-01
1.02942875000E-02	1.04952910295E-02	2.12639398572E+03	2.11969636108E+03	1.39116375088E-01	1.38456923605E-01
7.20600125000E-03	7.36642359490E-03	2.00092904488E+03	1.99485963519E+03	1.35701047532E-01	1.35191448652E-01
5.04420087500E-03	4.94987959995E-03	1.89014530201E+03	1.89531018374E+03	1.32709848671E-01	1.33308767979E-01
1.43750000000E-01	1.45967200636E-01	3.50433951258E+03	3.49582667278E+03	1.88049928575E-01	1.87578797991E-01
1.65312500000E-01	1.67667263594E-01	3.58512078780E+03	3.57624791748E+03	1.92695481352E-01	1.92081867443E-01
1.90109375000E-01	1.92391261202E-01	3.66575331809E+03	3.65724315985E+03	1.97742027810E-01	1.97034923298E-01
2.18625781250E-01	2.20554128406E-01	3.74645639979E+03	3.73904357292E+03	2.03249717972E-01	2.02518060009E-01
2.51419648437E-01	2.52636356888E-01	3.82750584816E+03	3.82192929243E+03	2.09290178985E-01	2.08625058257E-01
2.89132595703E-01	2.89198542699E-01	3.90924874821E+03	3.90624508243E+03	2.15950010698E-01	2.15486007075E-01
3.32502485059E-01	3.30904053319E-01	3.99213229185E+03	3.99243067446E+03	2.23336096840E-01	2.23170618243E-01
3.82377857817E-01	3.78558330851E-01	4.07679464760E+03	4.08107775208E+03	2.31585424674E-01	2.31892430964E-01
4.39734536490E-01	4.33190800348E-01	4.16422168530E+03	4.17305057577E+03	2.40883230548E-01	2.41814166917E-01
5.05694716963E-01	4.96194592379E-01	4.25835524569E+03	4.26968055838E+03	2.51556930922E-01	2.53154580025E-01
5.81548924508E-01	5.70170005156E-01	4.35800480741E+03	4.37393622839E+03	2.63972102081E-01	2.66177260564E-01
6.68781263184E-01	6.61057272181E-01	4.47600402539E+03	4.49308016318E+03	2.79335749795E-01	2.81202012029E-01
7.69098452662E-01	7.90291158789E-01	4.65526345740E+03	4.65450512918E+03	3.01633345836E-01	2.98619639541E-01
8.84463220561E-01	8.90396466656E-01	4.80552657554E+03	4.78144814675E+03	3.20222250685E-01	3.18911296823E-01

THE EQUILIBRIUM PRESSURE AND COMPOSITION OF PRODUCTS

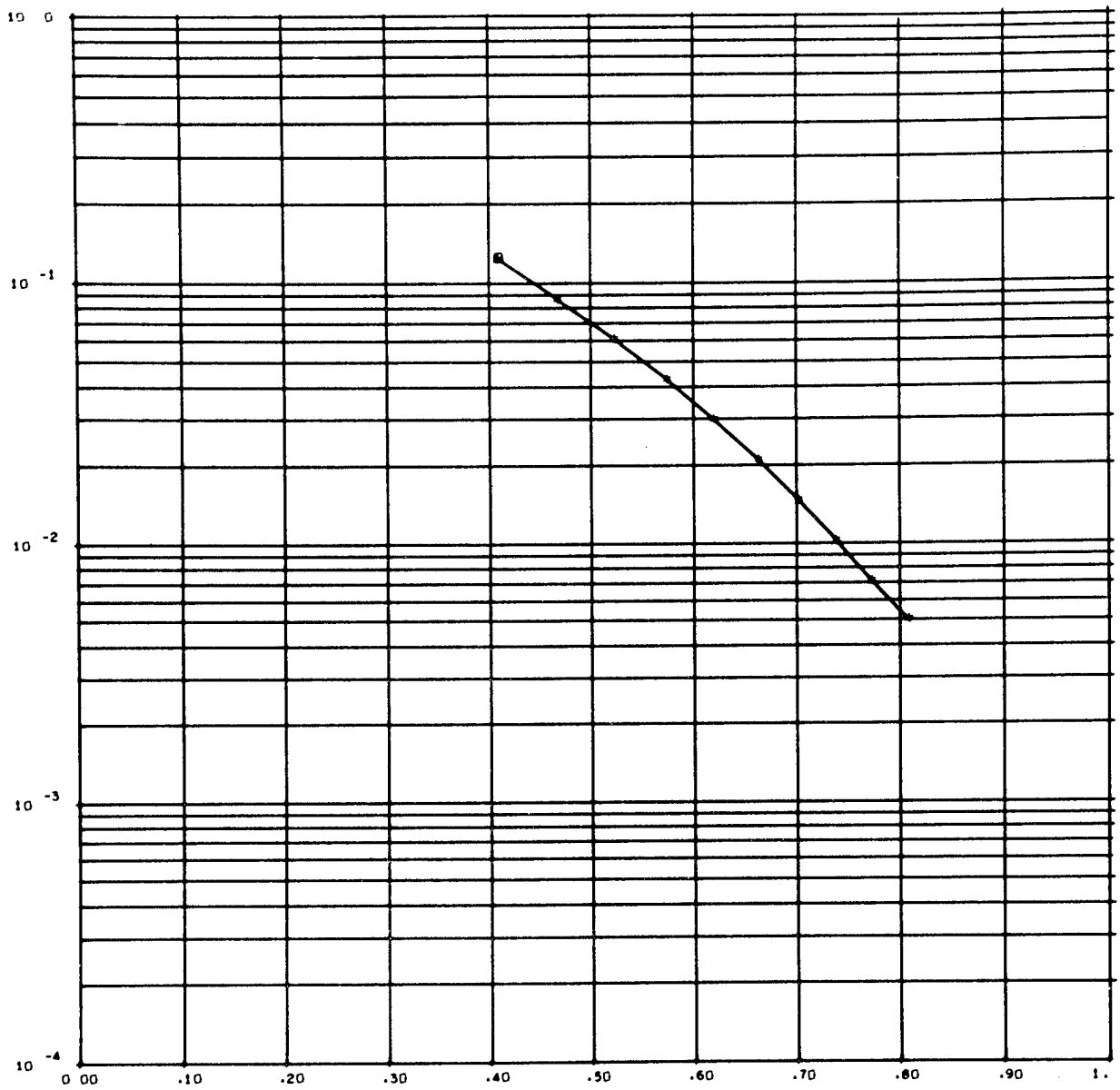
H2O	NH	NO	O2	CO	NH3	N	NO	N2	OH	CH4	SOL C		
1.25000000000E-01				4.80300584879E+00			7.70959093035E-01		1.01688033866E-07	6.95658926326E-03		1.20203025113E-01	
2.86099414499E-01				1.24546106639E-03			2.42470167744E-05		3.56938169242E-01	5.34971790921E-05		1.46522797865E+00	
1.09976124179E+01													
8.75000000000E-02				4.65931738757E+00			1.07339803188E+00		7.15866185829E-08	1.58455519396E-02		2.46891938683E-01	
2.33957994145E-01				1.30563143905E-03			1.83052271261E-05		3.83013900314E-01	8.11214702321E-05		1.42533018144E+00	
1.08119373279E+01													
6.12500000000E-02				4.43268201726E+00			1.38985232338E+00		3.88976430751E-08	3.12258096185E-02		4.42557512669E-01	
1.90588644661E-01				1.17581963477E-03			1.15861710871E-05		4.04699882084E-01	9.63868649257E-05		1.41287289081E+00	
1.06133437869E+01													
4.28750000000E-02				4.13572612263E+00			1.69894028129E+00		5.25430616246E-10	5.34453937924E-02		6.95283720846E-01	
1.55045580275E-01				9.18171133771E-04			6.12238823511E-06		4.26074159671E-01	9.12455012288E-05		1.43302927518E+00	
1.03182416102E+01													
3.00125000000E-02				3.79109664568E+00			1.99381492039E+00		3.88935895975E-10	8.14327725044E-02		9.83962287531E-01	
1.27941020019E-01				6.48113368305E-04			2.82375256359E-06		4.36027677669E-01	7.26972483173E-05		1.47890764863E+00	
9.95569729154E+00													
2.10087500000E-02				3.43340449495E+00			2.26627954952E+00		2.59683508795E-10	1.12973466454E-01		1.27859676139E+00	
1.05261269516E-01				4.24078645885E-04			1.17550901204E-06		4.47368777489E-01	5.06347147612E-05		1.53859334729E+00	
9.56903642485E+00													
1.47062500000E-02				3.09069000543E+00			2.51174082031E+00		1.51413530006E-10	1.46044649245E-01		1.55518222115E+00	
8.66606667455E-02				2.63557520721E-04			4.57871158959E-07		4.56669437693E-01	3.20167516917E-05		1.60121219350E+00	
9.19756093620E+00													
1.02942675000E-02				2.78161015387E+00			2.72819548120E+00		7.23226379115E-11	1.79300592202E-01		1.79776954715E+00	
7.13902921931E-02				1.58483652046E-04			1.71796480039E-07		4.64304768004E-01	1.89426356376E-05		1.65901010675E+00	
8.86791975309E+00													
7.20600125000E-03				2.51566040410E+00			2.91614557962E+00		2.51991263073E-11	2.12148079553E-01		1.99803264414E+00	
5.80997136640E-02				9.34449975947E-05			6.34353131219E-08		4.70550110350E-01	1.07291744730E-05		1.70739617770E+00	
8.58242305061E+00													
5.04420007500E-03				2.79344592080E+00			3.07799139257E+00		1.00000000000E-11	2.44582990515E-01		2.15338217551E+00	
4.87200364600E-02				5.45147127812E-05			5.76919924374E-10		4.75635971481E-01	5.91407695908E-06		1.74422018977E+00	
8.35761464216E+00													
1.43750000000E-01				4.84112236214E+00			6.61286873628E-01		1.08829745061E-07	4.83268415790E-03		8.71439877256E-02	
3.08918053210E-01				1.17127658832E-03			2.58034733436E-05		3.45727620158E-01	4.22606812624E-05		1.48460278064E+00	
1.09284205475E+01													
1.65312500000E-01				4.86965611660E+00			5.59081286310E-01		1.12240426014E-07	3.27465841977E-03		6.17355774279E-02	
3.31739479441E-01				1.07420903756E-03			2.67678414294E-05		3.34116876359E-01	3.19968103501E-05		1.50405013750E+00	
1.09309595288E+01													
1.90109375000E-01				4.89094613505E+00			4.65643484371E-01		1.11610872511E-07	2.15983834661E-03		4.26837033529E-02	
3.55549270595E-01				9.61925131423E-04			2.70803541316E-05		3.22211824525E-01	2.31813286247E-05		1.52229696073E+00	
1.09328504076E+01													
2.18625781250E-01				4.90643917429E+00			3.81954837357E-01		1.07028887186E-07	1.38262781078E-03		2.87525881795E-02	
3.79780040020E-01				8.41609679666E-04			2.67250432025E-05		3.10096617468E-01	1.60428128820E-05		1.53825355104E+00	
1.09316112350E+01													
2.51419540437E-01				4.91742619405E+00			3.08556908598E-01		9.89296492407E-08	8.55741629917E-04		1.88258163970E-02	
4.04351031570E-01				7.20007333873E-04			2.57242692931E-05		2.97811322180E-01	1.05841678588E-05		1.55106207727E+00	
1.09292563647E+01													
2.89132957035E-01				4.92500609680E+00			2.45538110444E-01		8.80404668413E-08	5.09563050115E-04		1.19438224685E-02	
4.29513362935E-01				C.02857110163E-04			2.41365918808E-05		2.85331260057E-01	6.64195958750E-06		1.56009051414E+00	
1.09274561005E+01													
3.32502485059E-01				4.93007995239E+00			1.92573724848E-01		7.53162510059E-08	2.90154877294E-04		7.31357860616E-03	
4.54087153774E-01				4.94566817920E-04			2.20532148061E-05		2.72545396781E-01	3.95540564473E-06		1.56488316591E+00	
1.09275131005E+01													
3.82377857017E-01				4.93336279513E+00			1.49008562119E-01		6.18038368373E-08	1.56846525251E-04		4.30156203529E-03	
4.81514383374E-01				3.90154520949E-04			1.95953541773E-05		2.59233010636E-01	2.23082026414E-06		1.56507843751E+00	
1.09304631539E+01													
4.39734536490E-01				4.93540568378E+00			1.13956283136E-01		4.85812242077E-08	7.98070748881E-05		2.41650588809E-03	
5.09916090002E-01				3.15339102238E-04			1.69086945922E-05		2.45033500222E-01	1.19032891434E-06		1.56030281604E+00	
1.09372008710E+01													
5.05694716953E-01				4.93661103802E+00			8.65681221205E-02		3.69874623270E-08	3.81594722697E-05		1.29769396944E-03	
5.40933745746E-01				2.48193918085E-04			1.42673564279E-05		2.29525993449E-01	6.07737374940E-07		1.55014791021E+00	
1.09485162364E+01													
5.81546924508E-01				4.93730079037E+00			6.54697151606E-02		5.96578242000E-10	1.67418302331E-05		6.53818791380E-04	
5.76603045711E-01				1.93614325685E-04			1.16124061563E-05		2.11692670941E-01	2.93578545184E-07		1.53361398598E+00	
1.09557154534E+01													
6.68781263186E-01				4.93766241577E+00			5.01312885913E-02		5.50107775646E-10	6.84475618910E-06		3.14373533567E-04	
6.18636524601E-01				1.54743109480E-04			9.37507342942E-06		1.90677048123E-01	1.41007099916E-07		1.50958703528E+00	
1.09900917484E+01													
7.69098452662E-01				4.93782726001E+00			4.08633138413E-02		5.29185812814E-10	2.89378908029E-06		1.58464427899E-04	
6.68369369092E-01				1.40669751557E-04			8.40617082935E-06		1.65811111968E-01	8.07508808122E-08		1.47684249803E+00	
1.10229961438E+01													
8.84463220561E-01				4.93793284019E+00			3.33422824936E-02		4.68257042631E-10	8.46192977138E-07		5.95285389977E-05	
7.40350748995E-01				1.17863055402E-04			5.93730621092E-06		1.29821660862E-01	6.42529164236E-10		1.42656991701E+00	
1.10733697085E+01													



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID
PRESSURE-VOLUME ISENTROPE



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID
TEMPERATURE - VOLUME ISENTROPE



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID
PRESSURE -PARTICLE VELOCITY ISENTROPE

APPENDIX D.

THE BKW HUGONIOT AND ISENTROPE FOR A 0.3-g/cc FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

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 A FORTRAN BKW CALCULATION FOR
FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

THE NUMBER OF ELEMENTS IS      4

THE NUMBER OF GAS SPECIES IS     11

THE NUMBER OF SOLID SPECIES IS      1

THE BKW EQUATION OF STATE PARAMETERS ARE
 ALPHA= 5.00000000000E-01 BETA= 1.60000000000E-01 THETA= 4.00000000000E+02 KAPPA= 1.09097784436E+01

THE COMPOSITION
     1.25000000000E+01 MOLES OF   C
     1.78700000000E+01 MOLES OF   H
     1.00000000000E+00 MOLES OF   N
     4.93800000000E+00 MOLES OF   O

THE DENSITY                  IS  3.00000000000E-01. GRAMS/CC

THE MOLECULAR WEIGHT IS  2.61153960000E+02 GRAMS

THE HEAT OF FORMATION AT 0 DEG K IS -2.25000000000E+05 CALORIES PER FORMULA WEIGHT

THE SOLID (COWAN) EQUATION OF STATE PARAMETERS    V0, AS, BS, CS, DS, ES,      A1, A2, C1, C2, C3, ATOMIC WT

SOL C   4.44444444444E-01   8.30935837268E-01  -1.39381809219E+00   6.72569716021E-01  -1.13537262508E-01   6.49155882007E-03
       -2.26705345948E-01   1.20516569525E-01   8.31600000000E-02  -1.75590000000E-01   1.55310000000E-01   1.20100000000E+01


THE INPUT            PRODUCT ELEMENTAL COMPOSITION MATRIX
  0        2.0E+00   0        1.0E+00   0        2.0E+00   0        0         0         0         0         2.0E+00
  1.0E+00  0         0        2.0E+00   1.0E+00  0         0        1.0E+00   0         3.0E+00   1.0E+00   0
  0        1.0E+00   0        0         0        0         1.0E+00  1.0E+00   0         0         2.0E+00   0
  0        1.0E+00   0        1.0E+00   1.0E+00  4.0E+00   0        0         1.0E+00   0         0         0


 THE BKW HUGONIOT FOR THE
FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

PRESSURE =  5.00000000000E-01 VOLUME =  4.81308783226E-01 TEMPERATURE =  9.31092389135E+03
SHOCK VELOCITY =  1.39568266166E+00 PARTICLE VELOCITY = 1.19415636456E+00 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND


 SPECIE    NO OF MOLES
H2O       3.80270892580E+00
H2        1.79318318838E+00
O2        2.21187977063E-03
CO2       3.77122359762E-02
CO        1.01636023803E+00
NH3       3.11317331142E-01
H         2.92995287673E-01
NO        2.46505627720E-02
N2        3.32016053043E-01
OH        1.44320419115E-02
CH4       1.35920911216E+00
SOL C     1.00867184138E+01
```

PRESSURE = 4.500000000000E-01 VOLUME = 5.038270371240E-01 TEMPERATURE = 9.077507344655E+03
SHOCK VELOCITY = 1.329342414720E+00 PARTICLE VELOCITY = 1.120374939410E+00 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	3.619638804330E+00
H2	1.759672622820E+00
O2	2.057332287740E-03
CO2	4.385930287580E-02
CO	1.186927703680E+00
NH3	3.117509159600E-01
H	2.735389836430E-01
NO	2.351563532330E-02
N2	3.323867243580E-01
OH	1.608450634410E-02
CH4	1.471625208980E+00
SOL C	9.797587786490E+00

PRESSURE = 4.000000000000E-01 VOLUME = 5.302342602180E-01 TEMPERATURE = 8.813674483970E+03
SHOCK VELOCITY = 1.259183355040E+00 PARTICLE VELOCITY = 1.058884708620E+00 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	3.415916819920E+00
H2	1.744279036570E+00
O2	1.830278805710E-03
CO2	4.990745767560E-02
CO	1.379078881420E+00
NH3	3.107444381900E-01
H	2.558895913440E-01
NO	2.186417346650E-02
N2	3.336956941720E-01
OH	1.766465223380E-02
CH4	1.585955181220E+00
SOL C	9.485058479690E+00

PRESSURE = 3.500000000000E-01 VOLUME = 5.613789165120E-01 TEMPERATURE = 8.509527309220E+03
SHOCK VELOCITY = 1.184456470770E+00 PARTICLE VELOCITY = 9.849773058480E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	3.193229768170E+00
H2	1.751179522150E+00
O2	1.533616550110E-03
CO2	5.534827441130E-02
CO	1.592359396340E+00
NH3	3.078889357880E-01
H	2.394625573370E-01
NO	1.963852985330E-02
N2	3.362362671790E-01
OH	1.900452371380E-02
CH4	1.699761682740E+00
SOL C	9.152530446510E+00

PRESSURE = 3.000000000000E-01 VOLUME = 5.980315791910E-01 TEMPERATURE = 8.142707575030E+03
SHOCK VELOCITY = 1.104117842900E+00 PARTICLE VELOCITY = 9.085074063900E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	2.956037127300E+00
H2	1.786361746760E+00
O2	1.188933024720E-03
CO2	5.956941797510E-02
CO	1.823814311980E+00
NH3	3.025578355880E-01
H	2.231235347820E-01
NO	1.680036700540E-02
N2	3.403208887030E-01
OH	1.983147170950E-02
CH4	1.800863343465E+00
SOL C	8.807982835390E+00

PRESSURE = 2.50000000000E-01 VOLUME = 6.45670807383E-01 TEMPERATURE = 7.70736652781E+03
SHOCK VELOCITY = 1.01662436264E+00 PARTICLE VELOCITY = 8.19702960727E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	2.71509964596E+00
H2	1.85851176999E+00
O2	8.18168001458E-04
CO2	6.19534679219E-02
CO	2.06431969844E+00
NH3	2.93787410516E-01
H	2.04441647409E-01
NO	1.33429166391E-02
N2	3.46434836423E-01
OH	1.96944691102E-02
CH4	1.90431970501E+00
SOL C	8.46940713063E+00

PRESSURE = 2.00000000000E-01 VOLUME = 7.04814485878E-01 TEMPERATURE = 7.12791439181E+03
SHOCK VELOCITY = 9.19469038385E-01 PARTICLE VELOCITY = 7.25052509114E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

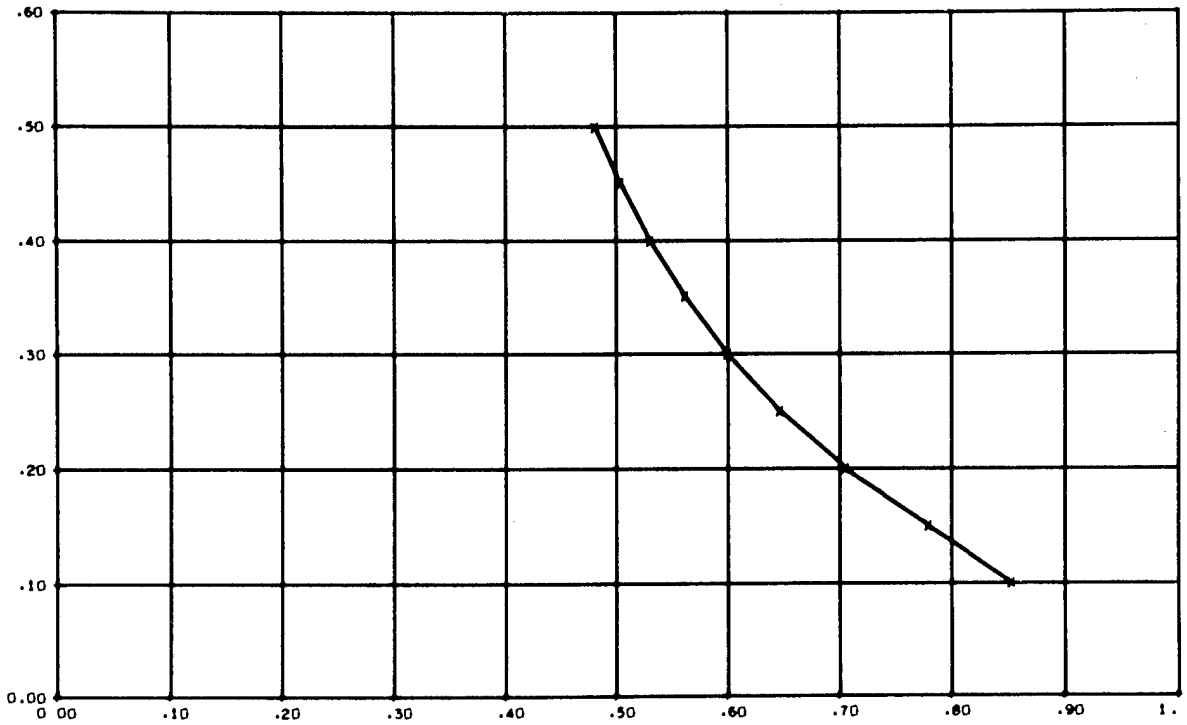
SPECIE	NO OF MOLES
H2O	2.49962825879E+00
H2	1.97806287496E+00
O2	4.63613266959E-04
CO2	6.21276146897E-02
CO	2.28605660035E+00
NH3	2.80050601345E-01
H	1.77667020483E-01
NO	9.31350089030E-03
N2	3.55317948882E-01
OH	1.78191840580E-02
CH4	1.96974493098E+00
SOL C	8.18207085399E+00

PRESSURE = 1.50000000000E-01 VOLUME = 7.79271713856E-01 TEMPERATURE = 6.27776715399E+03
SHOCK VELOCITY = 8.07806310885E-01 PARTICLE VELOCITY = 6.18956128381E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	2.41354163740E+00
H2	2.13990561101E+00
O2	1.75887750865E-04
CO2	6.06375848666E-02
CO	2.38509608756E+00
NH3	2.58757104563E-01
H	1.28476223802E-01
NO	4.68725314424E-03
N2	3.68177821146E-01
OH	1.28481166803E-02
CH4	1.96137746231E+00
SOL C	8.09288688526E+00

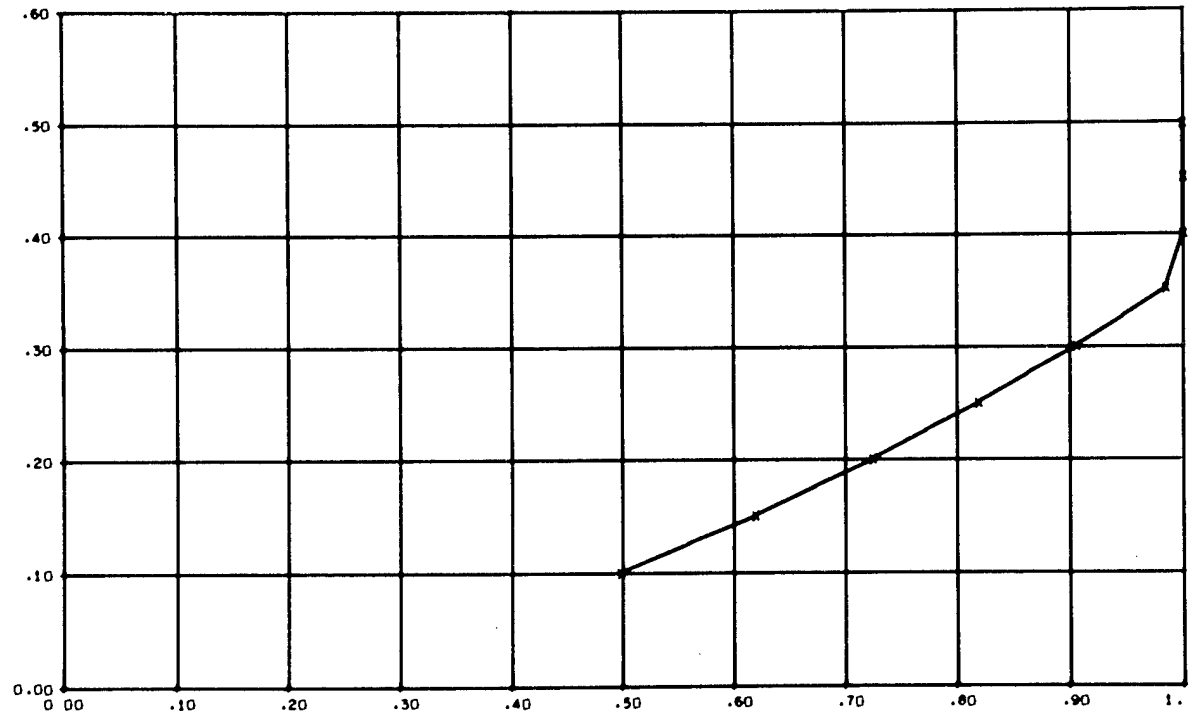
PRESSURE = 1.00000000000E-01 VOLUME = 8.52449191030E-01 TEMPERATURE = 4.80609037817E+03
SHOCK VELOCITY = 6.69226811938E-01 PARTICLE VELOCITY = 4.98082255603E-01 UNITS ARE MBARS,CC/GM, DEG K, AND CM/MICROSECOND

SPECIE	NO OF MOLES
H2O	2.94136033098E+00
H2	2.15495995205E+00
O2	1.82452818110E-05
CO2	5.85527230689E-02
CO	1.87454419792E+00
NH3	2.24241609033E-01
H	4.08203880633E-02
NO	9.71258027166E-04
N2	3.87393566470E-01
OH	3.98227641277E-03
CH4	1.73995798559E+00
SOL C	8.02694509341E+00



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

PRESSURE (MBARS) - VOLUME (CC/GM) HUGONIOT



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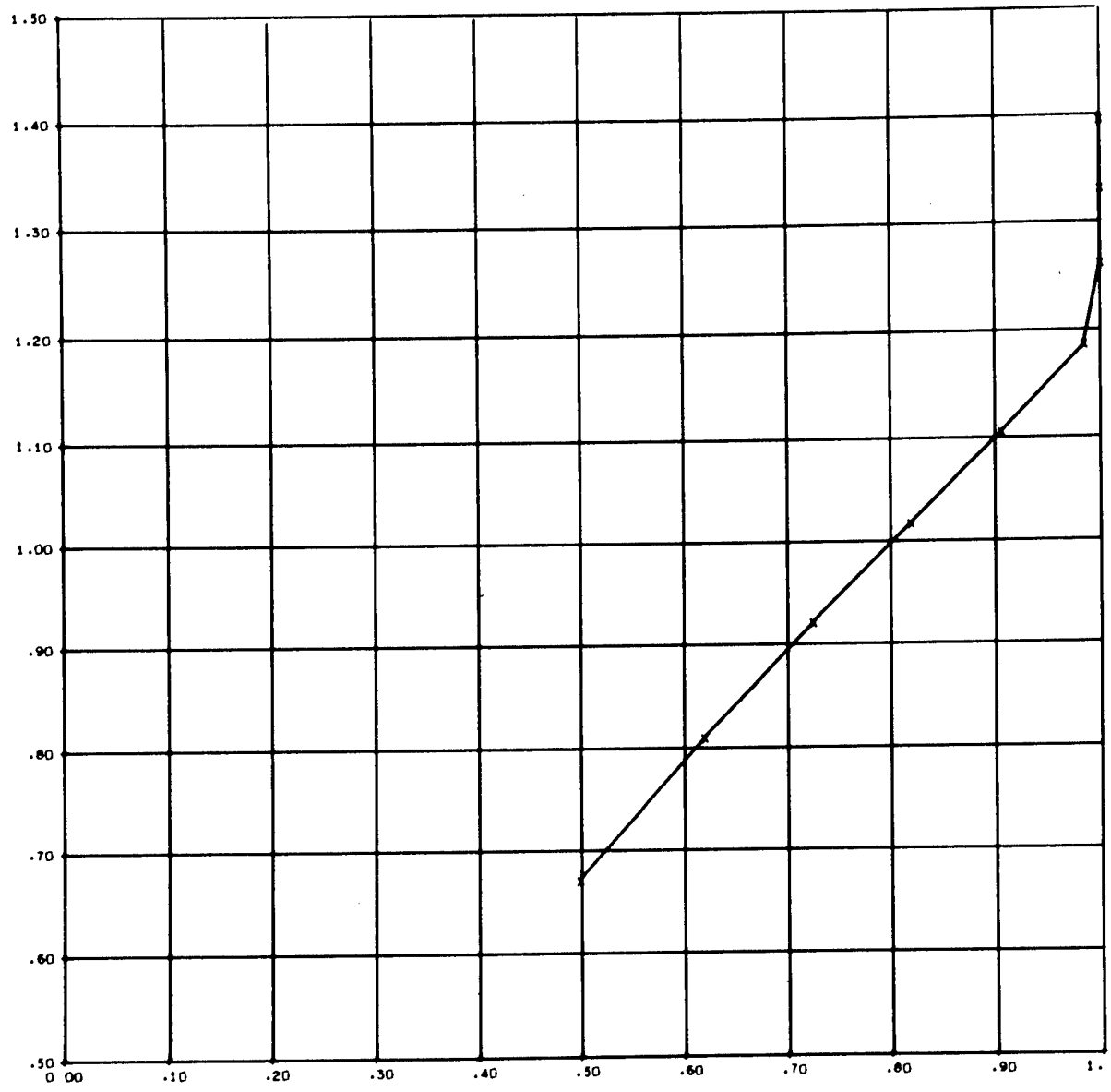
FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

PRESSURE (MBARS) - PARTICLE VELOCITY (CM/USEC) HUGONIOT



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

SHOCK VELOCITY - PARTICLE VELOCITY HUGONIOT

A BKW ISENTROPE
FOAMED MIXTURE OF URETHANE AND ADIPIC ACID

LN(P)= -2.74742042194E+00 -2.23201570268E+00LNV 2.74401757727E-01LNV**2 8.39523347149E-02LNV**3 -1.06311952204E-01LNV**4

LN(T)= 8.31657240019E+00 -5.29324822154E-01LNV -3.68145924866E-03LNV**2 8.99657015279E-02LNV**3 -1.32774092433E-02LNV**4

LN(E)= -9.26831008520E-01 4.31043946435E-01LNP 1.07114898469E-01LNP**2 1.81916702563E-02LNP**3 1.32874493625E-03LNP**4

THE CONSTANT ADDED TO ENERGIES WAS 1.000000000000E-01

PRESSURE (MBARS)	VOLUME (CC/GM)	TEMPERATURE (DEG K)	ENERGY+C (MB-CC/GM)	GAMMA (-DLNP/DLNV)	PARTICLE VELOCITY
9.000000000000E-02	8.62766499023E-01	4.41504934063E+03	2.11176735763E-01	2.30816978695E+00	4.71541087285E-01
6.300000000000E-02	1.01416158428E+00	4.03453526341E+03	1.99781658333E-01	2.22424967135E+00	5.35844498406E-01
4.410000000000E-02	1.19731786834E+00	3.68892325397E+03	1.90133674434E-01	2.12750073704E+00	5.94382820527E-01
3.087000000000E-02	1.42015204766E+00	3.38560099150E+03	1.81920271810E-01	2.02688005383E+00	6.47848660312E-01
2.160900000000E-02	1.69271301862E+00	3.12395763858E+03	1.74891271503E-01	1.93539604671E+00	6.96973091972E-01
1.512630000000E-02	2.02808670224E+00	2.89936243723E+03	1.68839708258E-01	1.86837604261E+00	7.42540960051E-01
1.058841000000E-02	2.44378844865E+00	2.70593740969E+03	1.63590599712E-01	1.84392990343E+00	7.85382791156E-01
7.411887000000E-03	2.96360271874E+00	2.53779079524E+03	1.58996909877E-01	1.88360957425E+00	8.26327639183E-01
5.188320900000E-03	3.61997730160E+00	2.38985968415E+03	1.54937330941E-01	2.01457099162E+00	8.66094263529E-01
1.035000000000E-01	8.10844239273E-01	4.57129340228E+03	2.16243364617E-01	2.33209523997E+00	0.
1.190250000000E-01	7.62231244662E-01	4.72543198885E+03	2.21563107169E-01	2.35394216405E+00	0.
1.368787500000E-01	7.17170349023E-01	4.88080307690E+03	2.27331939348E-01	2.37100244913E+00	0.
1.574105625000E-01	6.75186146061E-01	5.03284918205E+03	2.33491047904E-01	2.38294863567E+00	0.
1.810221468750E-01	6.36105225509E-01	5.18007834888E+03	2.40082545171E-01	2.38937335573E+00	0.
2.081754689063E-01	5.99727525248E-01	5.32075153097E+03	2.47137485538E-01	2.38993538173E+00	0.
2.394017892422E-01	5.65848803456E-01	5.45346627885E+03	2.54693412997E-01	2.38433947533E+00	0.
2.753120576291E-01	5.34248285812E-01	5.57730235736E+03	2.62799587787E-01	2.37231137754E+00	0.
3.166086662731E-01	5.04680595568E-01	5.69193547304E+03	2.71524226778E-01	2.35534634788E+00	0.
3.641001962140E-01	4.76871721191E-01	5.79768279834E+03	2.80963279764E-01	2.32762716016E+00	0.
4.187152256461E-01	4.50518352122E-01	5.89549273052E+03	2.91252836549E-01	2.29390713905E+00	0.
4.815225094931E-01	4.25278576078E-01	5.98690327658E+03	3.02588396672E-01	2.25132900698E+00	0.
5.537508859171E-01	4.00736165795E-01	6.07411924640E+03	3.15266930520E-01	2.19808093586E+00	0.
6.368135186804E-01	3.76278425411E-01	6.16053056244E+03	3.29801614596E-01	2.13072173259E+00	0.
7.323355466251E-01	3.50619070635E-01	6.25319807974E+03	3.47351226394E-01	2.04100059762E+00	0.
8.421856786181E-01	3.20196493609E-01	6.37395748050E+03	3.71305982991E-01	1.90229830860E+00	0.
9.685137604116E-01	2.96205236903E-01	6.47727629348E+03	3.92832668276E-01	1.76096469594E+00	0.

THE ISENTROPE STATE VARIABLES AS COMPUTED FROM THE LEAST SQUARES FIT

BKW PRESSURE	FIT PRESSURE	BKW TEMPERATURE	FIT TEMPERATURE	BKW ENERGY + C	FIT ENERGY
9.000000000000E-02	8.96097225206E-02	4.41504934063E+03	4.42192672916E+03	2.11176735763E-01	2.11611350941E-01
6.300000000000E-02	6.21159124309E-02	4.03453526341E+03	4.06077217779E+03	1.99781658333E-01	2.00571260822E-01
4.410000000000E-02	4.32787632807E-02	3.68892325397E+03	3.72060495919E+03	1.90133674434E-01	1.90947701014E-01
3.087000000000E-02	3.03622209880E-02	3.38560099150E+03	3.40885928067E+03	1.81920271810E-01	1.82462934129E-01
2.160900000000E-02	2.14484173473E-02	3.12395763858E+03	3.13082049918E+03	1.74891271503E-01	1.74973394269E-01
1.512630000000E-02	1.52166769409E-02	2.89936243723E+03	2.88978290647E+03	1.68839708258E-01	1.68443135084E-01
1.058841000000E-02	1.07739472500E-02	2.70593740969E+03	2.68752437882E+03	1.63590599712E-01	1.62925660937E-01
7.411887000000E-03	7.52989344877E-03	2.53779079524E+03	2.52508254274E+03	1.58996909877E-01	1.58553424558E-01
5.188320900000E-03	5.10696697523E-03	2.38985968415E+03	2.40354356282E+03	1.54937330941E-01	1.55536008455E-01
1.035000000000E-01	1.03485045866E-01	4.57129340228E+03	4.56669020506E+03	2.16243364617E-01	2.16414665548E-01
1.190250000000E-01	1.19618629064E-01	4.72543198885E+03	4.71329627667E+03	2.21563107169E-01	2.21537828741E-01
1.368787500000E-01	1.38143583582E-01	4.88080307690E+03	4.85938759817E+03	2.27331939348E-01	2.27022486452E-01
1.574105625000E-01	1.59446864951E-01	5.03284918205E+03	5.00472968320E+03	2.33491047904E-01	2.32917011968E-01
1.810221468750E-01	1.83830135584E-01	5.18007834888E+03	5.14816314262E+03	2.40082545171E-01	2.39277443910E-01
2.081754689063E-01	2.11614237040E-01	5.32075153097E+03	5.28861539900E+03	2.47137485538E-01	2.46186611383E-01
2.394017892422E-01	2.43131955740E-01	5.45346627885E+03	5.42506071352E+03	2.54693412997E-01	2.53665490149E-01
2.753120576291E-01	2.78748463444E-01	5.57730235736E+03	5.55659719753E+03	2.62799587787E-01	2.61854844519E-01
3.166086662731E-01	3.18899654083E-01	5.69193547304E+03	5.68250085871E+03	2.71524226776E-01	2.70837223422E-01
3.641001962140E-01	3.64152226542E-01	5.79768279834E+03	5.80223846517E+03	2.80963279764E-01	2.80729396695E-01
4.187152256461E-01	4.15288673916E-01	5.89549273052E+03	5.91542227513E+03	2.91252836549E-01	2.91667340307E-01
4.815225094931E-01	4.73447953635E-01	5.98690327658E+03	6.02173502878E+03	3.02588396672E-01	3.03809908556E-01
5.537508859171E-01	5.40410669696E-01	6.07411924640E+03	6.12084910663E+03	3.15266930520E-01	3.17343369485E-01
6.368135186804E-01	6.19362592057E-01	6.16053056244E+03	6.21240299290E+03	3.29801614596E-01	3.32487029780E-01
7.323355466251E-01	7.17737434324E-01	6.25319807974E+03	6.29620117319E+03	3.47351226394E-01	3.49500241337E-01
8.421856786181E-01	8.58568808144E-01	6.37395748050E+03	6.37026671509E+03	3.71305982991E-01	3.68691168960E-01
9.685137604116E-01	9.90348173491E-01	6.47727629348E+03	6.39974350877E+03	3.92832668276E-01	3.90427815027E-01

THE ISENTROPE PRESSURE AND COMPOSITION OF PRODUCTS

H2O	H2	O2	CO2	CO	NH3	H	NO	N2	OH	CH4	SOL C	
9.000000000000E-02	3.20462657483E+00		2.08247519606E+00		7.77436242874E-06		5.68260255801E-02		1.61675042699E+00			
2.14826644916E-01	2.51534796536E-02		5.22804737281E-04		3.92325275174E-01		2.43259355834E-03		1.65593261252E+00			
9.17049093491E+00												
6.300000000000E-02	2.74909812157E+00		2.64155365552E+00		2.69364879014E-06		6.37844257750E-02		2.05906039672E+00			
1.80363666433E-01	2.16025223953E-02		2.59264472679E-04		4.09688534547E-01		2.00797838161E-03		1.63099875643E+00			
8.74615644107E+00												
4.410000000000E-02	2.32305145084E+00		3.18652067363E+00		8.15946328319E-07		6.84146698597E-02		2.47654178450E+00			
1.48832169538E-01	1.68489736008E-02		1.16839432755E-04		4.25525495515E-01		1.45895361066E-03		1.59651282881E+00			
8.35853071683E+00												
3.087000000000E-02	1.93737355989E+00		3.69163291534E+00		2.27308157948E-07		7.11341053183E-02		2.85733767878E+00			
1.21305735859E-01	1.22937169343E-02		4.95450704798E-05		4.39322359535E-01		9.70551006642E-04		1.55870139350E+00			
8.01282682239E+00												
2.160900000000E-02	1.60163414774E+00		4.14297185842E+00		6.05426136660E-08		7.22327527762E-02		3.19127185210E+00			
9.81080511691E-02	8.58987079817E-03		2.03083661203E-05		4.50935820222E-01		6.08065141079E-04		1.51931647456E+00			
7.71717892057E+00												
1.512630000000E-02	1.32126103092E+00		4.53557740490E+00		5.22792730633E-10		7.21222538921E-02		3.47212009815E+00			
7.90552840430E-02	5.84020494122E-03		8.20700330139E-06		4.60466254467E-01		3.66157099619E-04		1.47823772853E+00			
7.47751992143E+00												
1.05884100000E-02	1.09604822395E+00		4.87058432703E+00		3.57930864637E-10		7.13570715486E-02		3.69901933717E+00			
6.36925341051E-02	3.90034691410E-03		3.31306213026E-06		4.68152076416E-01		2.14982004123E-04		1.43538549170E+00			
7.29423809959E+00												
7.411867000000E-03	9.21138141323E-01		5.15281724534E+00		2.27616107548E-10		7.05287052175E-02		3.87567885310E+00			
5.14547111701E-02	2.56997800998E-03		1.34586622069E-06		4.74271971482E-01		1.24248818111E-04		1.39125771658E+00			
7.16253472510E+00												
5.188320900000E-03	7.89203204504E-01		5.36882960967E+00		1.30352399941E-10		7.01664994891E-02		4.00839215537E+00			
4.17689839309E-02	1.67245537426E-03		5.51679564450E-07		4.79115232195E-01		7.10892035306E-05		1.34672096882E+00			
7.07472037832E+00												
1.035000000000E-01	3.36640004774E+00		1.86852341560E+00		1.12338620393E-05		5.33362539411E-02		1.44164830308E+00			
2.28780352523E-01	2.58883483911E-02		6.65908844936E-04		3.85286869316E-01		2.51076472278E-03		1.66132822556E+00			
9.34368721742E+00												
1.190250000000E-01	3.57386042007E+00		1.65823867093E+00		1.55627410071E-05		4.92480362888E-02		1.26227213836E+00			
2.42789386722E-01	2.59432240859E-02		8.23645476009E-04		3.78193483901E-01		2.49659804002E-03		1.66223845893E+00			
9.52624136642E+00												
1.360787500000E-01	3.75759978193E+00		1.45821659345E+00		2.08153867505E-05		4.46618500126E-02		1.08763527842E+00			
2.58819948178E-01	2.55021486642E-02		9.95105993370E-04		3.71092472914E-01		2.40450485973E-03		1.66000018825E+00			
9.70770268532E+00												
1.574105625000E-01	3.93858645338E+00		1.26875786560E+00		2.65805104914E-05		3.95353389488E-02		9.16901921874E-01			
2.70842361428E-01	2.44488053044E-02		1.16556494101E-03		3.63996036816E-01		2.22222088652E-03		1.65402836289E+00			
9.88953437628E+00												
1.810221468755E-01	4.11281696171E+00		1.09204053232E+00		3.22693463702E-05		3.39829484365E-02		7.53868825665E-01			
2.84907856806E-01	2.28492001648E-02		1.32052756575E-03		3.56885807814E-01		1.96324949008E-03		1.64518724798E+00			
1.006696097796+01												
2.081754689066-01	4.27620700955E+00		9.29431816459E-01		3.70632930342E-05		2.82004852613E-02		6.02224249636E-01			
2.99153627213E-01	2.07971051681E-02		1.44310080115E-03		3.49701635993E-01		1.65054290672E-03		1.63470345457E+00			
1.023487181056+01												
2.394017892426-01	4.42450971635E+00		7.81771066590E-01		4.01068325188E-05		2.24643922206E-02		4.65648686116E-01			
3.13795272625E-01	1.84199386289E-02		1.51764756200E-03		3.42343539906E-01		1.31495186289E-03		1.62407943144E+00			
1.038780749026+01												
2.753120576296-01	4.55400475608E+00		6.49431162618E-01		4.07660448149E-05		1.70868587625E-02		3.47217593906E-01			
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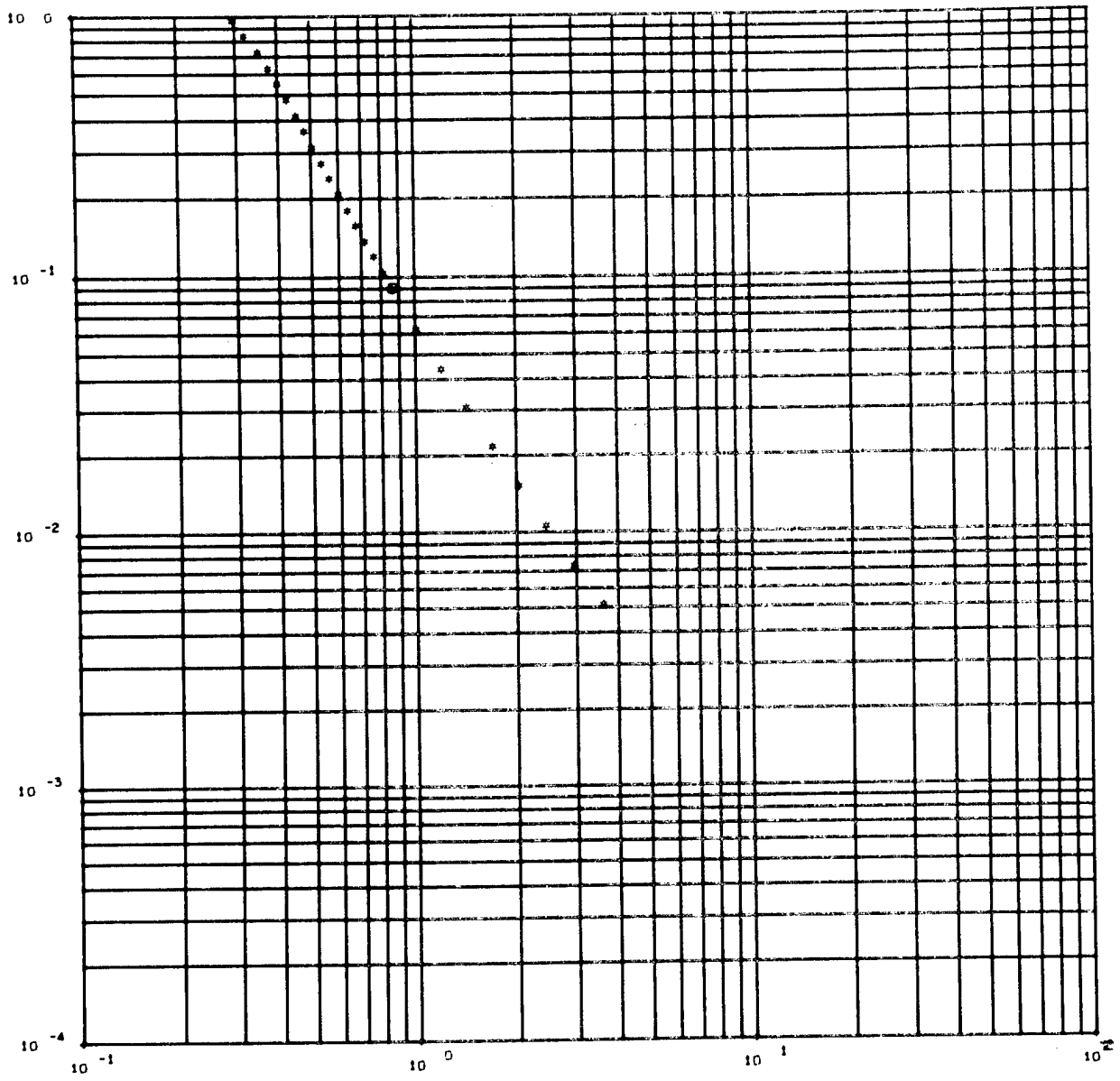
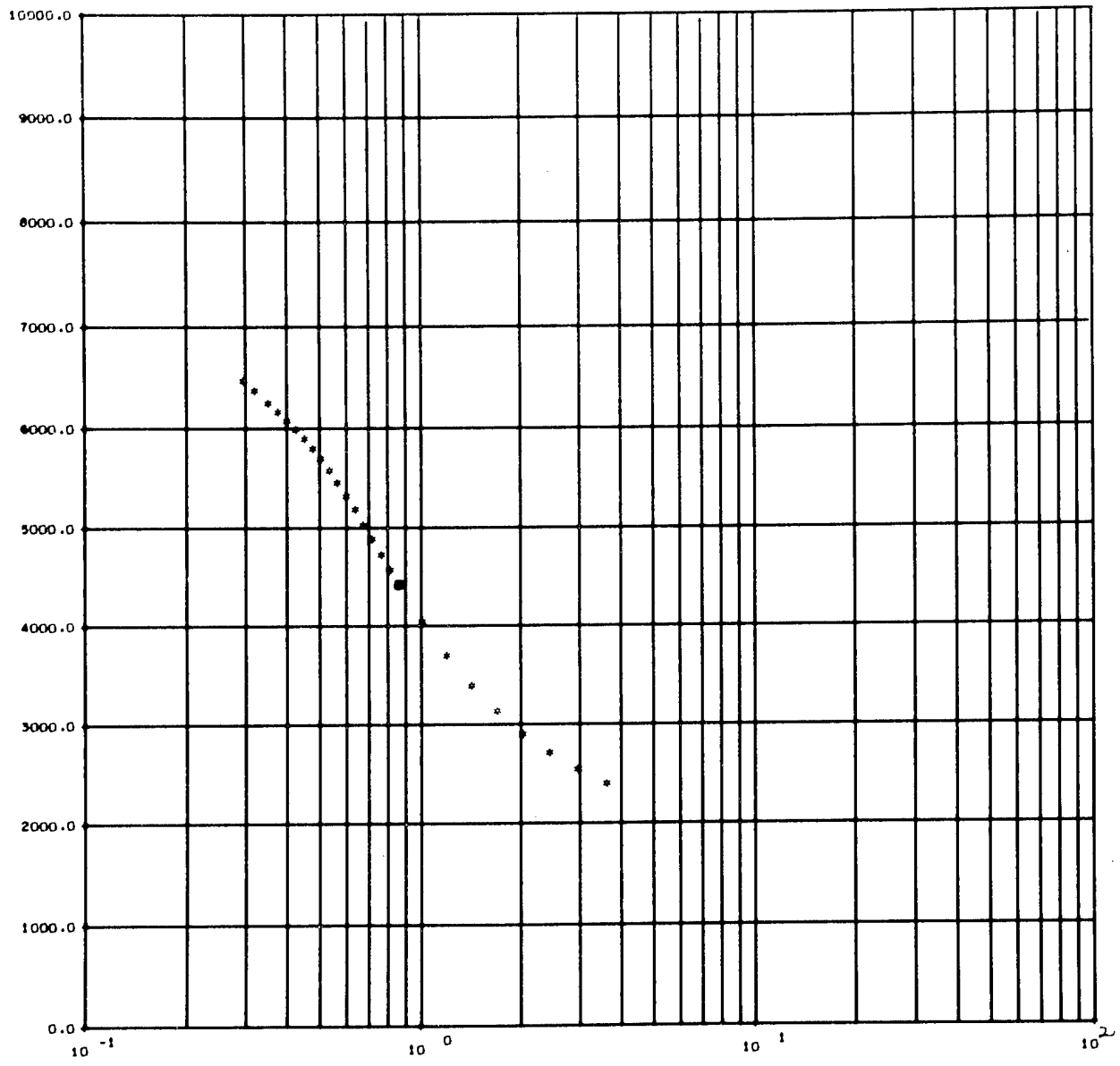
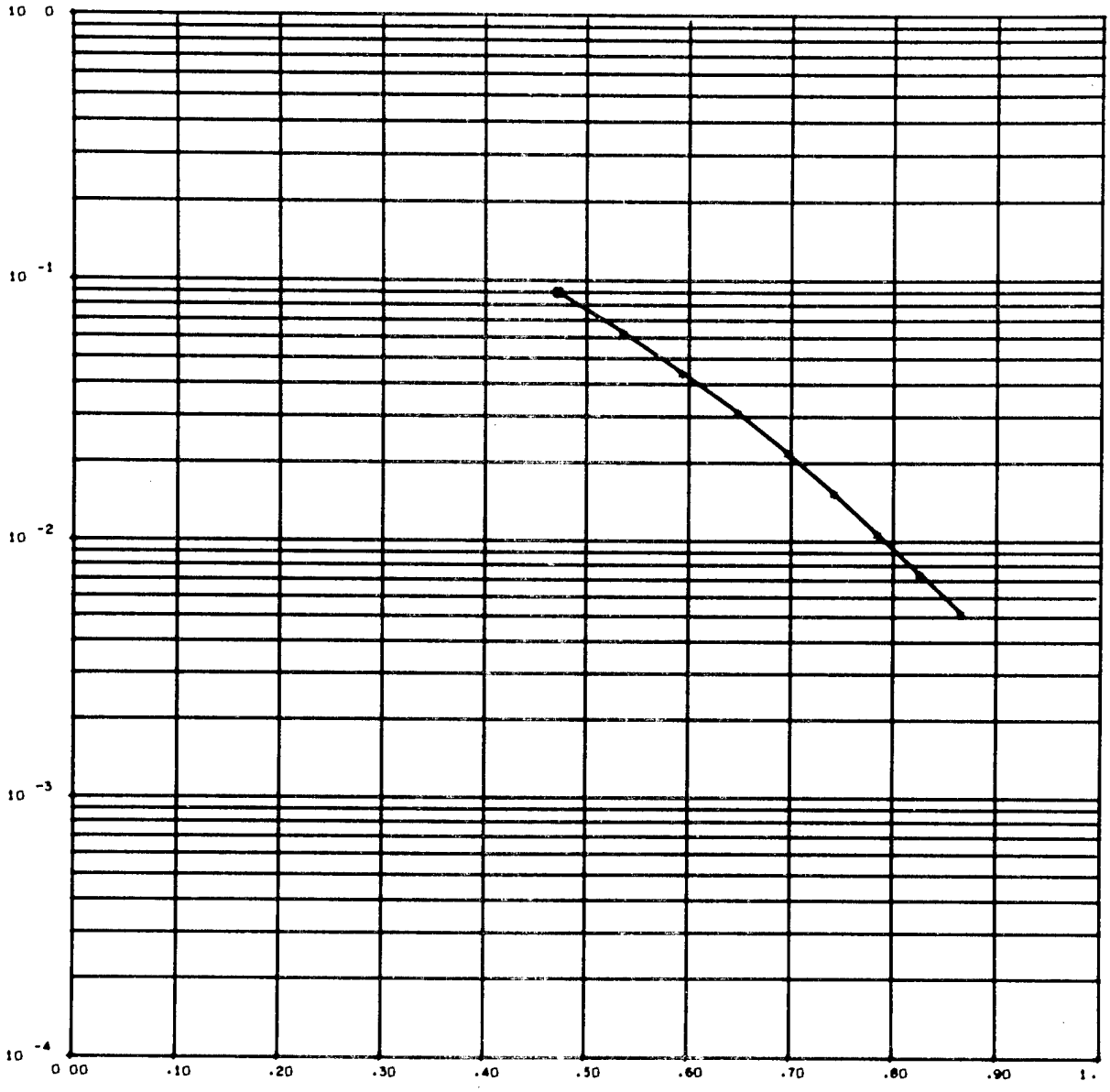


FOAMED MIXTURE OF URETHANE AND ADIPIC ACID
PRESSURE-VOLUME ISENTROPE



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID
TEMPERATURE - VOLUME ISENTROPE



FOAMED MIXTURE OF URETHANE AND ADIPIC ACID
PRESSURE -PARTICLE VELOCITY ISENTROPE