CALIBRATION OF A FLUID FOR USE
IN THE AQUARIUM TECHNIQUE
FROM -65F TO +165F

C. E. Canada

DEVELOPMENT DIVISION

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The purpose of this project is to extend the usefulness of the aquarium technique from -65F to +165F.

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Section JJ

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ABSTRACT

The usefulness of the aquarium technique has been extended from -65F to +165F by calibration of a fluid at four temperatures, -65F, -45F, room temperature and +165F. Linear least square curves were derived from (U_s , U_p)-data for each temperature. Listed Hugoniots are defined by equal slopes with intercepts at the longitudinal speed of sound for respective temperatures.

DISCUSSION

This report describes the continuation of previously reported work(1), in which Hugoniots of a dimethylpolysiloxane fluid, L-45* were determined at -45F, room temperature, and +165F. Determinations at -65F are discussed herein. The project is intended to extend the usefulness of the aquarium technique from -65F to +165F. Hugoniots of an aluminum oxide filled epoxy have already been determined using L-45 with the aquarium technique. Additional measurements consistent with the technique may be performed as needed.

EXPERIMENTAL TECHNIQUES AND RESULTS

Experimental and calculational techniques used to determine Hugoniots are described in Ref. 1. Aquariums were modified here by the addition of one-inch thick vacuum jackets. The jackets were added to decrease the rate of heat loss. With the evacuated space aquariums could be removed from their thermal environments up to 15 minutes prior to testing, whereas testing was necessary within 7 minutes for aquariums of Ref. 1.

Present measurements from which (U_s , U_p)-Hugoniots obtain are given in Table I. For completeness, results at other temperatures are also listed. Following the calculational scheme outlined in Ref. 1, the raw data for each temperature were first fitted with linear least-square curves. The four intercepts were found to be significantly different at a 5% error level, while the four slopes were found to have no significant difference at the same level(2). A slope of $0.945 \pm$

*Union Carbide Technical Bulletin, "Engineering with Silicone Fluids," 1971, L-45, 7 Centistokes

- (1) C. E. Canada, "Calibration of a Fluid For Use in the Aquarium Technique From -45F to +165F," Sandia (Albuquerque) Quarterly Report, April-June (1971).
- (2) Foreman S. Acton, Analysis of Straight Line Data, Dover Publications Inc., New York (1966)

0.055 at the 5% level, results from "pooling" all raw data. Using the calculational technique described in the reference with the slope of 0.945, Hugoniot's for L-45 were then derived as listed in Table II.

CONCLUSIONS

The temperature range over which the aquarium technique may be used has been extended from -65F to +165F by calibration of a suitable fluid. It should be noted, however, that the number of data points are limited and that only one experimental technique was used. Investigations with other techniques would permit increased confidence and estimates of experimental error.

Table I. Hugoniot Determinations

Temperature (F)	N_O (Index of Refraction)	ρ_O (g/cm ³)	$U(1)$ (mm/ μ sec)	U_S (mm/ μ sec)
-65	1.429	1.03	0.000 ^a	1.228
			1.544	2.880
			2.049	3.144
			2.176	3.269
			2.769	3.855
			5.000	5.892
-45	1.425	1.00	0.000	1.175
			1.544	2.575
			1.881	3.018
			2.140	3.350
			3.594	4.266
			4.551	5.452
R.T. ^b	1.398	0.94	4.909	6.071
			0.000	0.991
			1.170	2.019
			2.351	3.218
			3.091	3.760
			4.964	5.655
+165	1.380	0.89	0.000	0.825
			1.449	2.065
			1.557	2.302
			1.794	2.768
			2.236	2.762
			2.919	3.497
			4.878	5.274

^aValues for U_S at $U(1)$ equal zero obtain from exploding wire generated waves and are used as Hugoniot intercept values.

^bR.T. Ranged from 76 to 87 F.

Table II. Hugoniots of L-45^a

Temperature (F)	C_0^b (mm/ μ sec)	B^b	ρ_0 (g/cm ³)
-65	1.288	1.89	1.03
-45	1.175	1.89	1.00
R.T.	0.991	1.89	0.94
+165	0.825	1.89	0.89

^a(U_s, U_p) - Hugoniots have the form $U_s = C_0 + B*U_p$
with pressure in kilobars given by $P = 10*\rho_0*U_s*U_p$

^bCoefficients listed hold for $U_p \leq 2.5$ mm/ μ sec.