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SONIC-INDUCED CAVITATION IN LIQUID METALS AT 1500°F

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The pumping and handling of high-temperature liquid metals is of considerable importance to the space program, particularly liquid-metal Rankine cycle SNAP systems, and to several conventional nuclear power-plant concepts. For SNAP, particularly, minimization of size and weight, and maximization of temperature is of over-riding importance. Thus the fluid-handling equipment must operate in or nearly in a cavitating condition. Then cavitation will occur, and the resultant quantity and quality of damage must be known. The determination of materials showing the greatest cavitation resistance at elevated temperatures to be used in such components is the present objective.

The University of Michigan Nuclear Engineering Department ultrasonic cavitation facility has been already described[1,2]. Recently cavitation-erosion data have been obtained for 304 stainless steel, 316 stainless steel, a tantalum alloy (Ta-8W-2Hf), and Cb-1Zr in 70% Pb-30% Bi alloy at 1500°F. The test specimens were attached to the tip of an exponential horn, excited by a pair of lead-zirconate-titanate piezoelectric crystals at ~18 Kc/sec. with the horn tip immersed ~1½ inches into the molten Pb-Bi. The double amplitude at the specimen was ~2 mils. Test durations varied for the different materials, frequent inspections and weighings monitoring the specimen surface.

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Figure 1 shows accumulative MDP[*] vs. time for the various materials and typical photographs of the damaged surfaces. MDP-rate for 304 and 316 stainless steel is 11.6 mils/hour and 2.6 mils/hour, respectively. The corresponding rate for the tantalum alloy is 0.3 mils/hour (less than 304 stainless steel by $\sim$ x 39), and the Cb-1Zr rate was 0.1 mils/hour. The expectation that such refractory materials at elevated temperature are much more cavitation-erosion resistant than stainless steel is thus confirmed, although this was not the case at room temperature[3]. As yet no other comparable elevated temperature cavitation-erosion data has appeared.

Detailed examination of the 303 stainless steel exponential horn, the 316 stainless steel container vessel, and the sides of the various test specimens, all of which are not subject to cavitation-erosion damage, indicate that corrosion effects in these investigations were negligible.

Cavitation incipience (initial appearance of cavitation [illegible] local pressure is reduced) and desinence (disappearance of cavitation as local pressure is increased) points were also observed. It was found that for both stainless steels crystal voltage (related directly to oscillation amplitude) at incipience and desinence was $\sim$ 130 volts, whereas for Ta-8W-2Hf [illegible] volts, and for Cb-1Zr $\sim$ 70 volts. Hence, there was no [illegible] hysteresis effect (difference between incipience [illegible] points which sometimes occurs in flowing systems[4]). [illegible] lower voltages for Ta-8W-2Hf and Cb-1Zr are thought to in[illegible] decreased wetting of these alloys by Pb-Bi.

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[*] [illegible] depth of penetration (assuming weight loss smeared uni[illegible] over surface)

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