MATERION

TECH BRIEFS

Cavitation Resistance of Copper Alloys

Cavitation damage is caused by the repeated nucleation, growth and collapse of bubbles against a metal surface in a liquid. Cavitation is a form of erosion-corrosion which occurs on surfaces such as propellers, hydrofoils, pipelines, valves, engines, pump components and impellers that undergo large changes in liquid pressure. Bubbles that form rapidly collapse, producing shock waves against the surface resulting ultimately in metal removal. Materion Performance Alloys ToughMet® alloy and copper beryllium products are highly resistant to cavitation.

Material loading during exposure to a cavitating liquid is localized, dynamic and compressive in nature. Since the effect is highly localized, deformation of one grain or phase is not affected by the material surrounding or adjacent to the deforming region. Because of the highly localized and the dynamic severity of the loading condition during cavitation, correlation with "standard" material measurements, such as tensile properties, is extremely inconsistent and difficult. It is also difficult to draw performance comparison among similar alloys, even more so between different alloy classes. The difficulty in predicting cavitation behavior has, therefore, been primarily based on empirical data.

A standard practice is commonly used to evaluate metals for cavitation resistance. ASTM G32, "Cavitation Erosion Using Vibratory Apparatus", subjects a metal to cavitation in deionized water. This method is often used as a screening test to compare metal erosion from cavitation damage in a controlled environment. External factors such as dissolved or suspended particles, galvanic effects or corrosive environments are not covered by this test and should be treated as application specific. A series of copper alloys were subjected to this test procedure to compare, empirically, the resistance to cavitation damage in an inert environment. The alloys chosen are hardened by either solid solution, precipitation or spinodal decomposition and represent a wide range of strengths. Several of the alloys tested are commonly used in apps where cavitation is a common failure mode. A reference material, 4140 steel, was used to baseline the test results.

The results are shown in the graph. Several of the alloys are commonly used in cavitation prone environments, however, they performed poorly in the test. The manganese bronze (C67300) showed the greatest weight loss and most rapid erosion of the alloys tested. Exceptionally rapid damage was observed on the high-lead tin bronze alloy (C94100). The damage accumulation was so extensive with this alloy that the excitation amplitude was reduced to one half of the amplitude used for the other alloys to complete the tests.

The lowest weight loss and highest performance was demonstrated by ToughMet 3 alloy and Alloy 25, followed by the ToughMet 2 alloy. These alloys are among the highest strength copper alloys commercially available. The incubation time to initiate appreciable cavitation weight loss was also highest for these three alloys. As a reference, the high hardness 4140 steel showed a shorter incubation period compared to ToughMet 3 alloy and Alloy 25.

The cavitation testing was designed to provide a relative estimate of the resistance to cavitation the alloys tested are commonly used in applications where cavitation damage limits component life. These alloys were also found to have inferior performance in this standard cavitation resistance test. While the information presented in this Tech Brief is not intended for design purposes, the data illustrate that additional copper alloy choices are available for applications where cavitation resistance is critical to component performance and longevity.

SAFE HANDLING OF COPPER BERYLLIUM

Handling copper beryllium in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Safety Data Sheet (SDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact Materion Performance Alloys, Tech Service at 1-800-375-4205.

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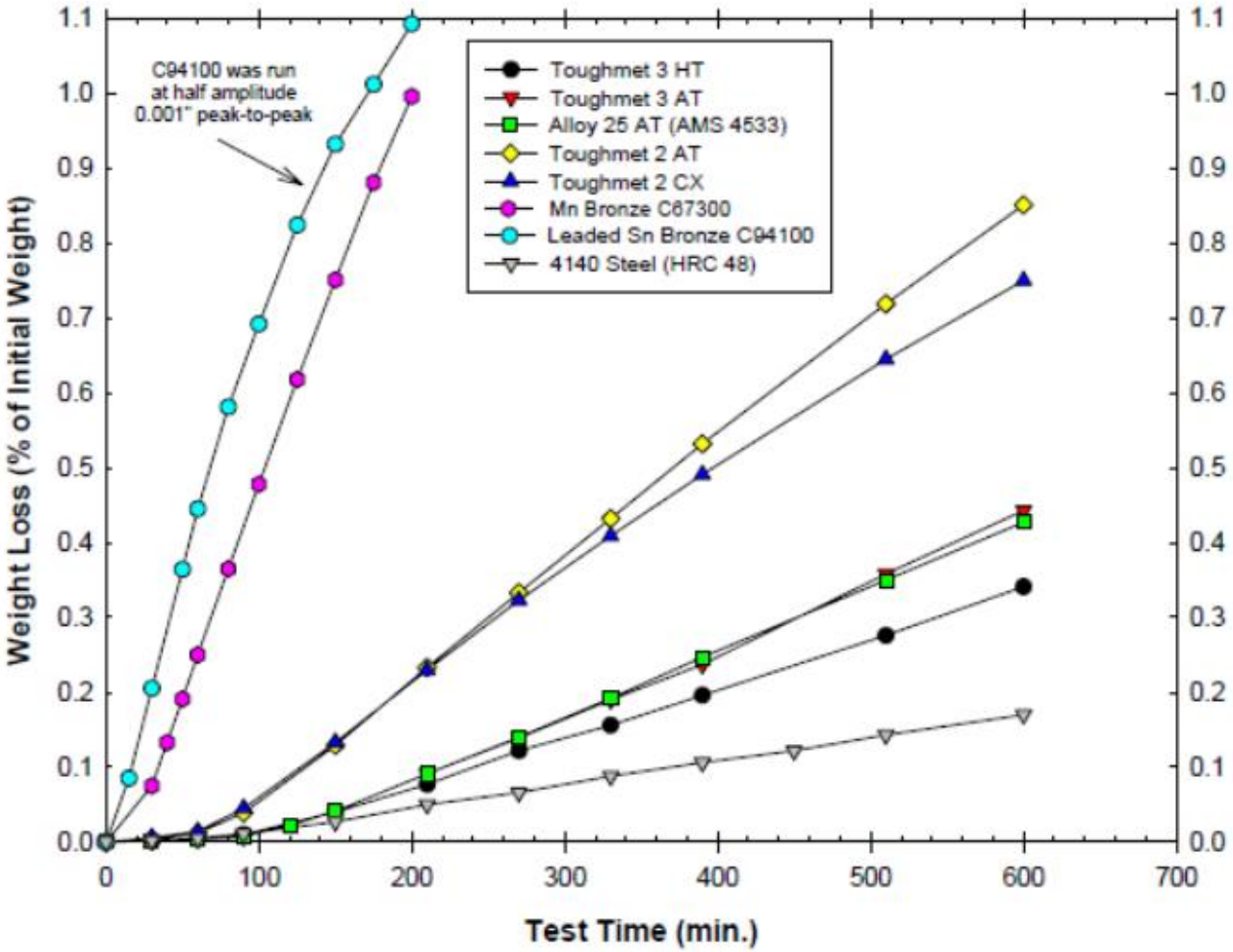

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