Cavitation Erosion Vibratory Test (ASTM G 32)

In this testing method, the surface of the test sample is immersed in a liquid and the cavitation process is produced by vibrational erosion. The longitudinal ultrasonic vibrations generated by this apparatus are amplified by the probe (horn) and transmitted into the liquid as ultrasonic waves consisting of alternate expansions and compressions causing erosion (material loss). This test method can be used to estimate the relative resistance of materials to cavitation erosion. This may be encountered in hydraulic turbines, on pump impellers, on ship propellers, valves, heat-exchanger tubes and other hydraulic structures in contact with high-velocity liquids subjected to pressure changes. The testing sample (tip) is weighed accurately before testing. The tip is threaded into the probe (horn) and immersed into a container of the test liquid (generally distilled water) that is maintained at a specified ambient temperature and pressure (Fig 1). The probe is activated at a frequency of 20 kHz with an amplitude of 50µm, for a predetermined duration. The test/interruption cycle is repeated to evaluate the mass loss behavior versus time (which is not linear), since most tested materials display an "incubation period". The longer the incubation time before major weight loss occurs, the higher the material's cavitational erosion resistance.

Principle of wear by cavitation erosion

Cavitation, as a physical phenomena, involves the formation and collapse of gas/vapor bubbles within a liquid caused e.g by velocity changes. When the pressure in a fluid drops below the vapor pressure, a bubble is formed. When the pressure increases again, bubbles will implode resulting in the formation of a liquid micro jet by the collapsing bubble surface. This jet is schematically illustrated in Fig 2, a) and shown in-situ in b). If the bubble is near a solid boundary/surface, then this liquid jet acts as water hitting the surface. Combined with the typical shock wave during collapse, both of these mechanisms can result in cavitation erosion damage in the materials. The impingement pressure caused by the cumulative collapse of bubbles was estimated in the literature to be in the order of 900 MPa which can lead to locally strain hardening and an eventual fatigue failure of ductile materials, or to crack propagation in brittle materials.

Standard testing parameters

Testing frequency:	20 ± 0.2 kHz.
Amplitude:	50 µm ± 5%
Suspension medium:	Distilled water (standard test)
Testing interval:	After 2 hours testing, cleaning, drying, weighing (other intermittent intervals can be also agreed on)
Cumulative time:	Up to 10 hours (standard)

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Typical Standard Method

ASTM G32: Standard Test Method for Cavitation Erosion Using Vibratory Apparatus

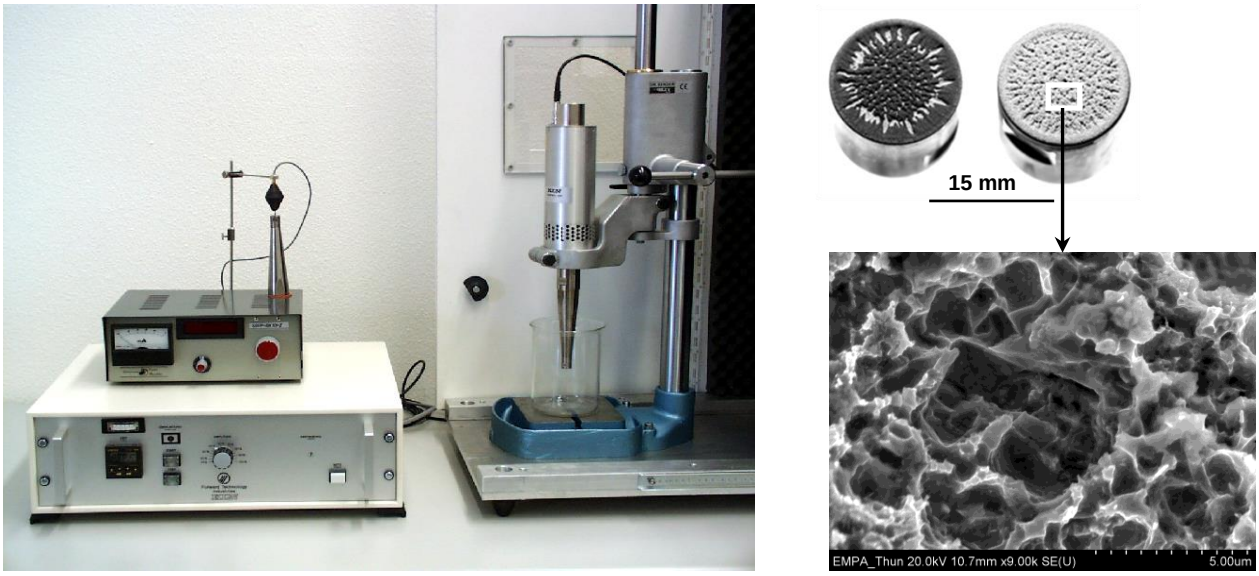

Figure 1: Cavitation erosion set-up with tested samples morphology with the corresponding SEM micrograph of worn surface (WC-Co-Cr) coating.

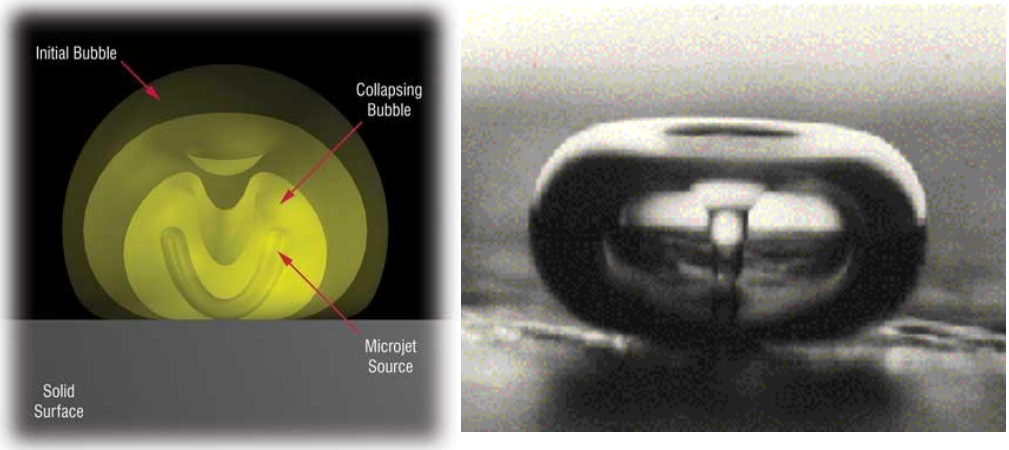

Figure 2: a) schematically illustrated vapor bubble collapse and the birth of a microjet, b) photograph of actual collapsing cavitation bubble (Ref.: Center for Industrial and Medical Ultrasound, University of Washington)

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