Standard Practice for Liquid Impingement Erosion Testing:

Summary and Notes

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1. Scope:

Objective of testing is to determine the resistance to erosion of a specific material or coating, or to determine the mechanisms leading to damage. No standardised method exists due to the various operating conditions that may be desired to simulate. ASTM provides guidance for test set-up, testing and analysis procedures, and reporting requirements.

Note: Collateral damage considered to be the erosion or degradation of testing equipment (e.g. windows).

4. Summary of Practice:

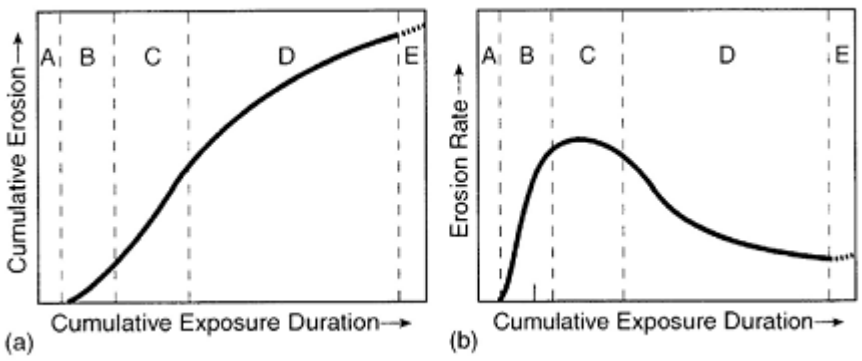
4.1. Apparatus must be calibrated in relation to a reference material (Section 8) for sprays (Section 6) or jets (Section 7).
4.2. Data analysis done based on cumulative erosion curve from measured mass lass (Section 9), further characterised (Section 10) by incubation and max erosion rate.
4.3. For comparative evaluation results must be normalized.

5. Significance and Use:

Liquid impingement erosion and cavitation erosion are similar. Both cause damage by high-intensity pressure pulses acting on a surface. Erosion resistance depends on: material, detailed nature, scale, intensity of the fluid-solid interactions.

Note: It has not yet been possible to successfully correlate erosion resistance with any independently measurable material property; thus consistency in measurements between facilities and conditions in not good, 20% error.

A: Incubation Period
B: Acceleration
C: Max erosion rate
D: Deceleration
E: Possible terminal steady state



For bulk materials determination of incubation period and maximum erosion rate are the objected. After which empirical relationships can be used to determine these parameters at differing liquid impingement conditions.

For long-life components terminal steady state (if exists) must be determined experimentally.

Note: These practices are recommended for 60-600m/s, at very low velocities corrosion effects become increasingly important. At velocities >600m/s material removal mechanism can change, depending on specimen temperature.

Note: cavitation tests (Method G 32 or G 134) may be less expensive and recommended for metals, though liquid impingement test are recommended for coatings, brittle materials, elastomers, since the impact velocity, droplet sizes, and be controlled more accurately.

6. Apparatus:

6.2. Classifications:

Distributed impact test: devices that use sprays or simulated rainfall
Repetitive impact test: device using jets (Provide much higher impact frequency, higher severity factor, thus produce erosion faster)

6.3 – 6.8 Parameter Control:

Should be able to:

- Maintain speed steady within 0.5% and measure within 0.1%
- Measure droplet diameter within 10%. (Typically range from 0.1-5mm)
    - Apparatus should be characterised by the drop population per unit volume in the path traversed by the specimen, repeatability, as function of test settings.

7. Test Specimens:

7.2. Attachment of specimen must ensure that repeatable alignment can be obtained. Specimen holders must minimize localized stresses due to clamping forces, or centrifugal forces.

7.3. Surface roughness can greatly affect incubation period; typical values 0.4-1.6μm rms. Selection of values outside of recommended range should be documented.

8. Reference Materials; Apparatus Calibration:

8.1. Minimum of two reference materials must be used listed in 8.3. They will be used to provide reference for normalized resistance value of the test material and to determine the severity factors of the test facility. (Section 10 – normalized erosion; Section 11 – Severity factors)

9. Test Procedures:

9.1. Introduction:
Testing procedures will vary depending on the nature of the material used.

9.2 Structural Materials
9.3. Elastomeric Coatings
9.4. Window Materials
9.5. Transparent Thin-Film Coatings on Window Material

9.1.2. Minimum of three specimens needed to be tested at each test variation

9.2. Test Procedure for Structural Bulk Materials and Coatings:

9.2.2. Primary test result is to obtain cumulative erosion-versus-time curve; generated by periodically stopping test, removing and weighing the specimen, recording mass loss and corresponding volume loss versus cumulative exposure.

Note: Photographs, topographic and metallographic observations of the eroded surface as well as hardness measurements can be taken for complete data set.

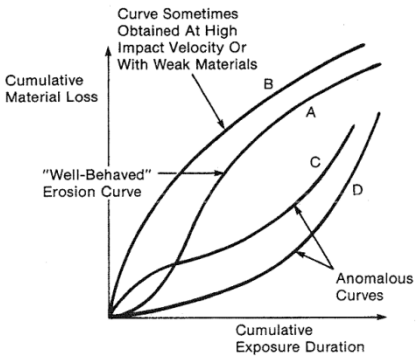
10. Calculation of Erosion Resistance:

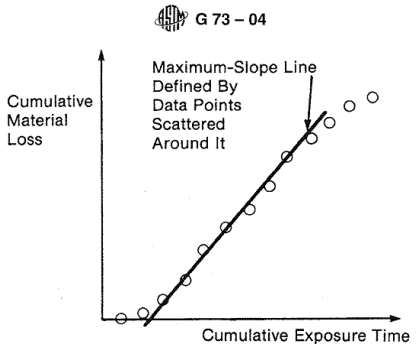
10.1 Introduction:

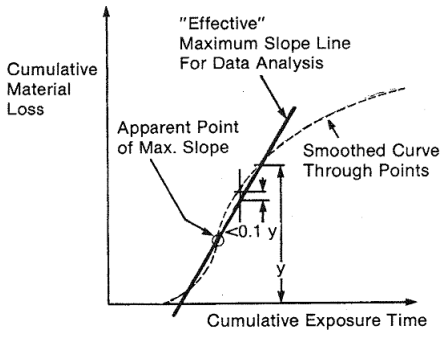
There is a lack of any accepted complete physical model for relating erosion performance to material parameters and variables describing impingment conditions. It is for this reason that comparative evaluations of materials must be carried out.

All evaluations of means, standard deviations, and other statistical evaluations should be done on the logarithms of the physical quantities. (If this is not done the standard deviation can be equal in magnitude to the mena.

Curve B: Cause by high speed impingment
Curve A: Welbehaved erosion curve







11. Expressing Test Results in Rationalized Terms and Determining Apparatus Severity Factors:

Note: If the objective of the test is to simply determine the relative erosion resistance of the material tested then Section 10 will suffice. To develope empirical models, make quantatative comparisons between results from different impingement conditions, verify theoretical predictions, then test results must be expressed in terms of rational physically meaningful variables. (Section 11)