Influence of manufacturing process on Cavitation Erosion on CoCrWMoCFeNiSiMn (Stellite 1) alloys

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Agenda

- Introduction
- Aims
- Methodology
- Results & Discussion
- Conclusion

Introduction

Cavitation Erosion

- **What is cavitation?**
  Collapse of bubbles and the resulting high-frequency high-pressure shock waves. Caused by fluid pressure dropping to vapor pressure, which is particularly common with high fluid flow speeds [1].
- **Why does it matter?**
  Cavitation erosion leads to removal of material, crack growth, and part failure. Affects turbine blades, pump impellers, valves, stirrers, etc.

Example (A screenshot)

Stuff

Stellite mind map

This slide consists of some text with a number of bullet points:

Why

A simple slide

This slide consists of some text with a number of bullet points:

- the first, very @important@, point!
- the previous point shows the use of the special markup which translates to the Beamer specific *alert* command for highlighting text.

The above list could be numbered or any other type of list and may include sub-lists.

A more complex slide

This slide illustrates the use of Beamer blocks. The following text, with its own headline, is displayed in a block:

Theorem (Org mode increases productivity)

- *org mode means not having to remember LaTeX commands.*
- *it is based on ascii text which is inherently portable.*
- *Emacs!*

□

Two columns

- this slide consists of two columns
- the first (left) column has no heading and consists of text
- the second (right) column has an image and is enclosed in an example block

Example (A screenshot)

Stuff

Aims

Methodology

Methodology - ASTM G32 Cavitation Erosion Testing

Naturally aerated seawater at room temperature.

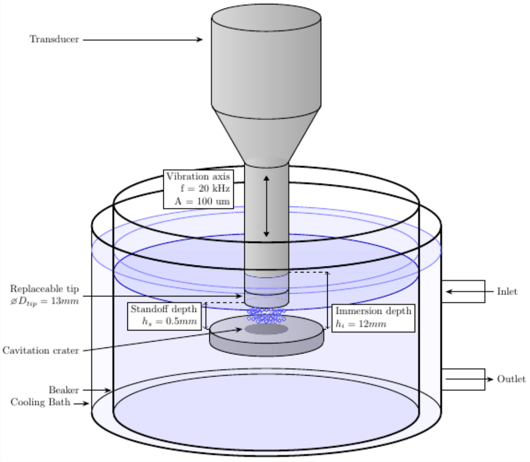

Figure 1: ASTM G32 apparatus for cavitation testing

Methodology - ASTM G32 Cavitation Erosion Testing

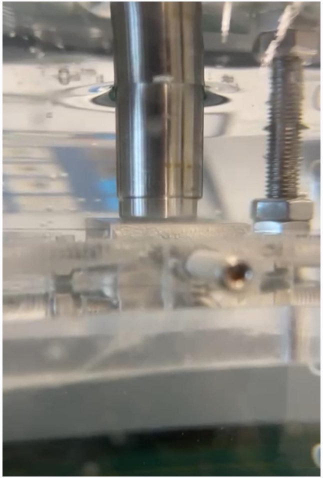

Figure 2: ASTM G32 apparatus in operation

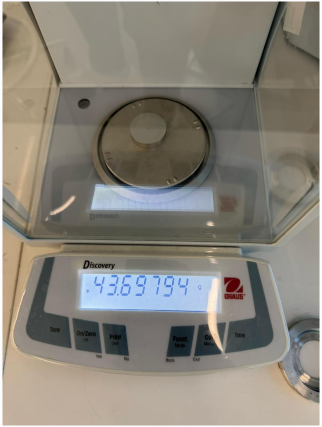

Figure 3: Analytical Balance

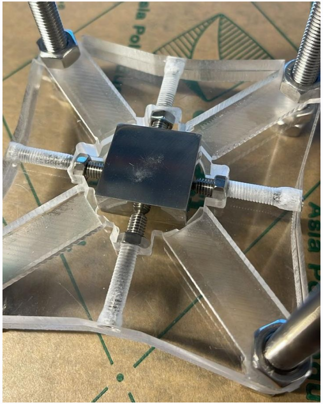

Figure 4: Custom CNC-cut sample holder

Methodology - Seawater Filtering and pH

- Seawater was vacuum filtered in order to remove algae and suspended particles
- Seawater pH was measured after calibrating pH meter with buffer solutions of pH 7 and pH 14.

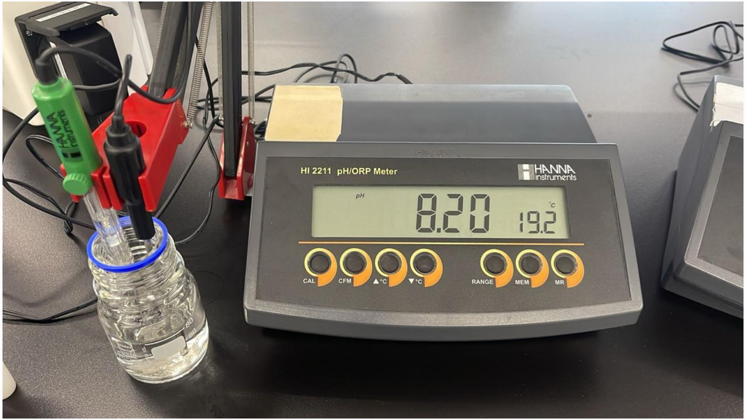

Figure 5: pH Meter reading of seawater

Methodology - Electrochemical Setup

- Instrument:
  Corrtest CS310 Potentiostat
  connected to conventional three-electrode cell.
- Working Electrode (WE):
  The sample, with an exposed area of $2cm^2$.
- Reference Electrode (RE):
  Saturated Calomel Electrode (SCE).
- Counter Electrode (CE):
  Graphite plate.
- Electrolyte:
  Naturally aerated seawater at room temperature.

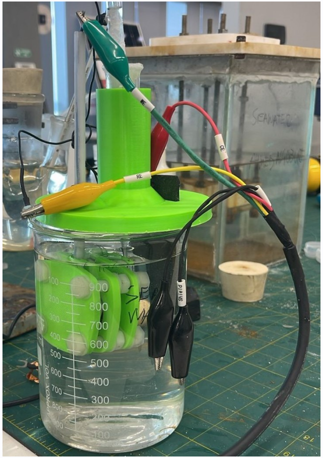

Figure 6: Three-electrode electrochemical setup

Methodology - Electrochemical Setup

Figure 7: Embedded sample after test, with corroded region

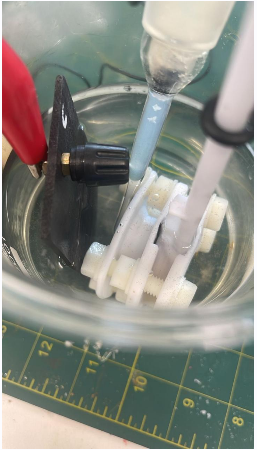

Figure 8: Top View of electrochemical setup

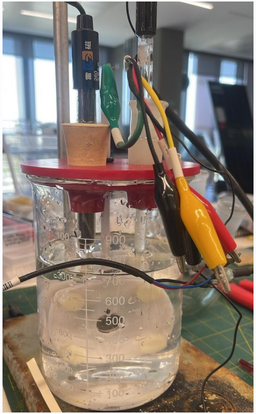

Figure 9: Initial prototype with platinum counter electrode

Methodology - Electrochemical Tests

- Open Circuit Potential (OCP)
  Before each electrochemical test, OCP was measured for one hour to ensure each sample reaches equilibrium, before EIS and LPR (explained below).
- Electrical Impedence Spectroscopy (EIS)
  The electrical response of the sample's interface with naturally aerated seawater
  - Frequency - 10^5 Hz $\rightarrow$ 10^{-1} Hz
  - Excitation voltage - **10 mV** and **20 mV**
  - Spacing - 20 per decade, logarithmic
- Linear Polarization Curve (LPR)
  The current density through the sample with an externally imposed voltage
  - Voltage - -20 mV wrt OCP $\rightarrow$ 20 mV wrt OCP
  - Scan rate - 0.1 mV/s
  - Data Acquisition rate - 10 Hz

The constituent phases were examined by X-ray diffraction

- Cu $K\alpha$ radiation ($\lambda = 1.5406\,\text{Å}$),
- Bragg-Brentano $\theta : 2\theta$,
- diffraction angle range $2\theta \in [10^\circ, 80^\circ]$,
- step size of 0.02°,
- scanning time of 0.5 sec/step,
- sample rotation enabled

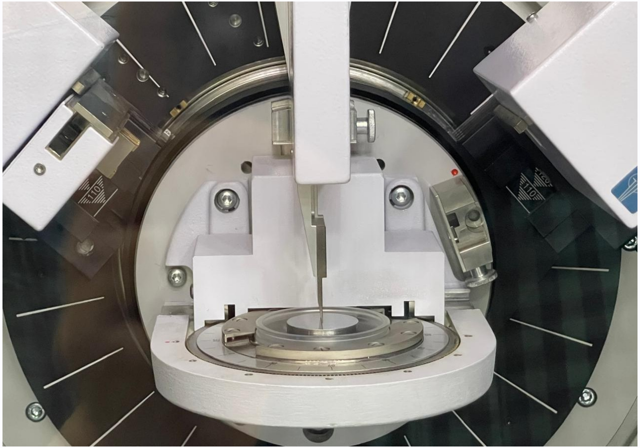

Figure 10: As-cast sample in the Bruker D8 Advance

- Optical Microscopy (OM)
  Images were taken with Amscope metallurgical optical microscope
  - eyepiece magnification 10X
  - auxiliary magnification 5X, 10X, 20X, 50X, 100X
- Scanning Electron Microscopy (SEM) Images were taken with Vega TESCAN and Oxford Instruments
  - Secondary Emission (SE)
  - Backscattered Electrons (BSE)
  - Energy Dispersive X-ray Spectroscopy (EDS)

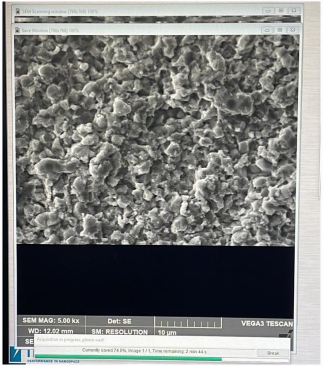

Figure 11: Screenshot of Vega TESCAN software during data acquisition of BSE image

Results & Discussion

Conclusion

References

[1] A. K. Krella, *"Degradation and Protection of Materials from Cavitation Erosion: A Review,"* *Materials*, vol. 16, no. 5, p. 2058, Jan. 2023, ISSN: 1996-1944. DOI: 10.3390/ma16052058. Accessed: Jun. 5, 2025.