Process Specific Control Summary

Ram Electrical Discharge Machining (EDM) on Copper Beryllium Alloys

Purpose
This document has been developed to communicate the results of case studies performed on specific operations where copper beryllium (CuBe) alloys are processed and to provide the reader with information on exposure and exposure control options such as work practice, administrative and engineering controls.

Introduction
An airborne beryllium exposure assessment was conducted during Ram Electrical Discharge Machining (EDM) of CuBe Alloy 25. The intent of the study was to characterize worker exposure to airborne beryllium and identify work practice and local exhaust ventilation (LEV) controls necessary to maintain exposures to consistently below the Recommended Exposure Guideline (REG).

Charmilles Technologies Roboform 41 Ram EDM

Exposures from Ram EDM?
Ram EDM uses spark erosion to remove metal. When sufficient voltage is applied, the dielectric oil ionizes and controlled sparks melt and vaporize the work piece. As the metal melts and vaporizes, metal fumes are emitted. To control visible fuming and potential exposures, a properly designed ventilation system is recommended when conducting EDM on beryllium-containing alloys.

> *Read the SDS specific to the products in use at your facility for detailed information on the health effects of exposure to beryllium.*

Airborne Exposure Standards

- BeST utilizes a Recommended Exposure Guideline (REG) of 0.6 µg/m^3 (inhalable sampling method) and 0.2 µg/m^3 (total-closed face filter cassette/CFC Total sampling method) which has proven effective when used in concert with the remaining elements of the Beryllium Worker Protection Model.

Baseline Exposure Evaluation
Twelve (12) Full shift exposure samples, using the CFC Total method, were collected in the breathing zone of operators performing Ram EDM on CuBe Alloy 25 plate. The EDM was operating all throughout the sampling period.

Post Intervention Personal Sample Results (CFC Total Method))

Number of Samples	Range µg/m³	Percent Exceedance[1] at 0.2 µg/m³	UTL(95/95)[2] µg/m³
12	<0.007 – 0.016	<0.1	0.031

[1]Percentage of exposures expected to exceed 0.2 µg/m³ (comparable to 0.6 µg/m³Inhalable). A percent exceedance of < 5% is considered to be "Well Controlled".
[2]Upper Tolerance Limit – one can be ninety-five-percent confidence that fewer than 5% of measurements are above the UTL(95/95)

Operating Conditions

The following conditions were noted during the baseline exposure evaluation.

- The voltage was set to 200V during the sampling period.
- The operator adjusted safety guard, was often left in the down position to allow the operator to observe the work from a distance while working on nearby machining tasks.
- Visible fume was observed escaping the existing hoods with the safety guard in both the up and the down positions.
  - A process air sample obtained with the filter in the plenum of the escaping fume was 1.8 µg/m^3.
- The Ram EDM is located in a relatively open shop environment with estimated room dimensions of 130' x 70' x 20' and a room air volume of 182,000 ft^3.

Exposure Controls in Use during Baseline Characterization

Existing exposure controls in place on the Charmilles Technologies Ram EDM include:

- A Manufacturer supplied local exhaust ventilation (LEV) system:
  - Two 6" x 1" slot hoods on opposite sides of the Ram
  - When in operation, the two hoods are positioned approximately 6" on each side of the Ram and 4" above dielectric fluid bath.
  - Exhaust air flow is supplied through low pressure Dayton model 4YJ32, 1/10 horsepower (hp) blower/motor assembly operating at 1400 revolutions per minute (rpm).
  - Face velocity of the hoods averaged 539 feet per minute (fpm).

Exposure Characterization Summary - Evaluation Interpretations

- The operator's personal exposure results were reliably below the REG for airborne beryllium when measured as an 8-hour TWA.
- The manufacturer's air moving equipment was not adequate to remove visible emissions as evidenced by the 1.8 µg/m^3 process sample result. Based on the very small particle size generated and the negligible control costs, it was determined that increasing the ventilation was prudent.
- The work practice of leaving the safety guard in the down position can contribute to inefficient fume capture due to the potential effect of cross drafts.
- In this case study, the release of metal fume did not contribute significantly to operator exposure due primarily to the large room volume in to which it was released (182,000 ft^3). Visible fume being released into a smaller room volume is likely to increase operator exposure.

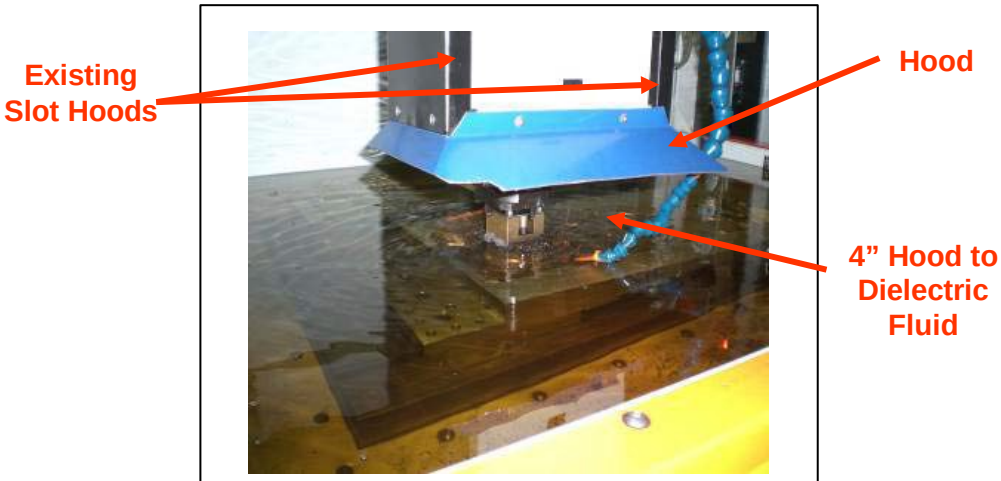
Recommendations

- Design exposure control improvements to capture fumes and to control visible emissions.
- Inform operators of the potential effects of room cross drafts on fume capture efficiency and the importance of keeping the safety guard in up position.

- Conduct post intervention exposure characterization to insure that exposure are and remain reliably below applicable regulatory limits and the REG.
- Implement the remaining elements of the Beryllium Worker Protection Model. Please review the Be Responsible at www.berylliumsafety.eu.

Exposure Control Improvements

- In order to improve the effectiveness of the LEV, the following upgrades were implemented:
  - A flanged hood with a 45° taper measuring 15" x 8" was designed and installed around the existing slot hoods and encircling the electrode.
  - The face of the flanged hood is positioned 4" above the dielectric fluid bath during operation.



New 45° Tapered Hood
Installed on Ram EDM

- The manufacturer supplied blower/motor assembly was replaced with a high pressure American Fan (AF-8) and Baldor 1/3 hp motor.
  - Air velocity measurements at the face of the hood averaged 159 fpm.
  - Air flow rate calculated at face of the hood equaled 162 cfm.
- A High Efficiency Particulate Air (HEPA) filtered fume collector rated at 200 cfm is used to filter process exhaust where required by air permitting authorities.
- Visible fume escape was not observed using the new hood. The results of a process air sample obtained 1" outside the perimeter of the hood was 0.026 µg/m^3.

Cost Information

- American Fan (AF-8) with Baldor 1/3 hp motor @ 3450 rpm.
  - $ 400.00
- Flanged hood with a 45° taper measuring 15" x 8" (fabricated?)
  - $200.00
- Torit-Donaldson VS500 fume collector (if required by air permitting agency)
  - $3500

SUMMARY

OPERATIONS

It is not known under what conditions exposures can be maintained to reliably below the applicable occupational exposure limits when unventilated or poorly ventilated Ram EDM is performed. To insure that exposures are maintained reliably below applicable occupational exposure limits

machining processes that generate small particles (e.g., Ram EDM) must be controlled with appropriate work practices and engineering controls.

MAINTENANCE
Under certain conditions, the repair or maintenance of equipment can generate airborne particles. Protecting workers can require the use of specific work practices or procedures involving the combined use of ventilation, wet and vacuum cleaning methods, respiratory protection, decontamination, special protective clothing and when necessary, restricted work zones. Detailed procedures for safely maintaining the process equipment and ventilation systems should be developed. All operators and maintenance personnel need to be trained in the established procedures prior to performing maintenance or service activities.

ADDITIONAL INFORMATION

The information contained in this document applies only to the subject referenced in the title. Read the SDS specific to the products in use at your facility for more detailed environmental, health and safety guidance.

The Be Responsible can be viewed at www.berylliumsafety.eu.

The foregoing is provided solely for informational purposes, based upon data believed to be correct and up to date, and is not to be construed as a warranty, express or implied, of any kind. The information above may not apply to a user's manufacturing operations; it is the responsibility of the user to determine safe conditions for the use of beryllium-containing products in its own operations and to comply with all applicable health and safety laws. Users should not rely solely on this information to make decisions about exposure control, but should consult with experts who can evaluate the users' operations and make specific recommendations tailored to those operations.

Additional information may also be available by contacting:

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