UC RIVERSIDE | Environmental Health & Safety

Biological Safety Cabinets (BSCs): Open Flames and Flammable Gas

Introduction

The CDC Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th Edition states: "Open flames are neither required nor recommended in the near microbe-free environment of a biological safety cabinet. On an open bench, flaming the neck of a culture vessel will create an upward air current that prevents microorganisms from falling into the tube or flask. An open flame in a BSC, however, creates turbulence that disrupts the pattern of HEPA-filtered air being supplied to the work surface."[1]

While it was standard practice in the past to use open flames to create an updraft of air for sterility while working out in the open bench, biological safety cabinets provide for this sterile field within the work space without the need for open flames. Other reasons for using open flames within a BSC such as sterilizing tools or instruments can be accomplished with safer alternatives. The use of open flames and flammable gas in a biological safety cabinet can compromise the function of the cabinet and potentially lead to fires or explosions.

Guidance

In consideration of the aforementioned CDC guideline, recommendations from the manufacturers of biosafety cabinets, laboratory safety risk assessments, incidents involving fires inside of biosafety cabinets, and similar guidance or policy from other UC campuses, UCR EH&S is providing the following guidance:

EH&S *strongly recommends* that the practice of using open flames and Bunsen burners inside of biological safety cabinets be discontinued.

Explanation

The use of Bunsen burners or open flames inside of a biological cabinet is **not** recommended for the following reasons.

1. It disrupts airflow, compromising the protection of the worker and the product. Class II BSCs maintains product protection by delivering HEPA filtered laminar airflow (air traveling in a single direction at constant speed without turbulence) down over the work area of the cabinet. This HEPA filtered airflow creates a sterile air environment within the cabinet. The heating of air from a Bunsen burner or open flame causes up-flow of air that mixes with the down flowing laminar airstream to produce turbulence and cross circulation within the working area, thus jeopardizing product and personnel protection.

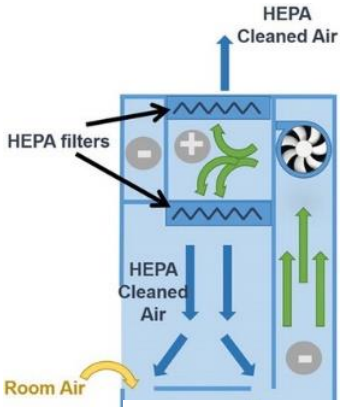

Figure 1. Side view of Class II Type A2 BSC

2. It causes excessive heat build-up within the cabinet and can be a source of fires. Since Class II Type A2 cabinets, the most common type on campus, recirculates 70% of the air within the cabinet, heat from the Bunsen burner or open flame builds up over time. The excessive heat can inactivate or degrade research materials, thus affecting research results. In addition, concentrations of the flammable gas could reach **explosive potential** and pose a serious risk to not only the BSC, but to the user and the laboratory it occupies. Also, open flames within the cabinet can be a **source of fire ignition** for other materials within the cabinet, such as ethanol/alcohols and other easily flammable materials like paper towels.

Figure 2. Glass shards remain in the sash frame after an explosion

Figure 3. Fire as a result of use of open flame in a BSC

Figure 4. Fire caused by open flames in BSC

3. It may damage the HEPA filter or melt the adhesive holding the filter together, compromising the cabinet's protections. An open flame has the capacity to melt the bonding agent that holds the HEPA filter media to its frame. This destroys the HEPA filters' effectiveness at capturing aerosols and particles, leading to loss of sterility and containment.

Figure 5. Damage to a HEPA filter caused by heat

4. It could nullify manufacturer's warranties on the cabinet and automatically void UL approval. In the event of a fire, explosion, or worker exposure due to the use of a flammable gas in the cabinet, cabinet manufacturers will assume no liability.

> As previously stated, NuAire doesn't recommend the use of natural gas within the BSC and **ASSUMES NO RESPONSIBILITY FOR ITS USE. USE AT YOUR OWN RISK.**

Figure 6. Statement from NuAire's Technical Bulletin regarding use of natural gas/Bunsen burner within a BSC

Alternatives

Recommendations for safer alternatives to using open flames inside of a BSC are listed below in order of preference. Use of open flames inside a BSC must have good scientific justification. Please consult with EH&S if open flames must be used.

1. Disposable tools and supplies – Many vendors sell pre-sterilized disposable tools and supplies such as inoculating loops, spreaders, and needles.



2. Pre-sterilize instruments – Instruments can be placed in autoclaveable trays/containers or special sleeves manufactured for this use to sterilize tools prior to use.


3. Non-flame alternatives
   a. Bacti-Cinerator – Utilizes infrared heat to incinerate organic material deep within the ceramic funnel.

   b. Glass Bead Sterilizer – Glass beads in the well are maintained at 250°C for complete destruction of microorganisms and spores in seconds.

c. Electric Bunsen Burners – Directs radiant heat up in one direction so user can heat items regardless of their shape. Caution should be noted that the radiant heat can potentially damage the HEPA filters similar to an open flame.

4. On-Demand Flames - While these units are safer than constant on flames, the use of natural gas and open flames can still disrupt the airflow within the cabinet, lead to potential fires, or can cause explosions if there are any leaks in the gas line. A higher level of caution must be used with these units.

   a. Safety Laboratory Gas Burners – Safety enhanced laboratory gas burners with "Touch Free" IR sensors or button function.

   b. Touch-O-Matic – provides flame only when needed.

References

[1] Biosafety in Microbiological and Biomedical Laboratories, 6th Edition, Appendix A, Part 5 – BSC Use by the Investigator: Work Practices and Procedures.

Figures

1. Source: Applied Biosafety Vol. 24, No. 2 https://www.liebertpub.com/doi/10.1177/1535676019831173

2. Source: Al-Dahhan et al. Laboratory biological safety cabinet (BSC) explosion. Karbala International Journal of Modern Science. 2016. https://www.sciencedirect.com/science/article/pii/S2405609X16303736

3. Source: University of Massachusetts Biological Safety Cabinet Management Program Document Number EHS.BSC.08.01. https://ehs.umass.edu/sites/default/files/BioCabinetManagement.pdf

4. Source: Stanford University Biosafety Manual Chapter 9.5 – Biological Safety/Biosafety Cabinets. https://ehs.stanford.edu/manual/biosafety-manual/biological-safety-biosafety-cabinets

5. Source: LabConco – 4 Reasons NOT to use open flames in Biosafety Cabinets. https://www.labconco.com/articles/4-reasons-not-to-use-flames-in-bscs

6. Source: NuAire – General Technical Bulletin: Use of Natural Gas or Bunsen Burner within a Biosafety Cabinet. https://www.nuaire.com/-/media/Project/Nuaire/Resources/bulletin-general/use-of-natural-gas-or-bunsen-burner-within-a-biosafety-cabinet.pdf

Other UC Campus Guidance/Policy on Use of Open Flames in BSCs

https://rsawa.research.ucla.edu/ibc/use-open-flames/

https://www.ehs.uci.edu/research-safety/biosafety/_pdfs/Bunsenburner_BSC.pdf

https://blink.ucsd.edu/safety/research-lab/biosafety/containment/bsc/open-flame.html