BSC MythBusters: Does Heat Really Affect Protection?



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BSC MythBusters

- There are a lot of rules, "guidelines", rumors, and myths for using a Biosafety Cabinet.
- Which are true?
- Which are not?
- WHY?





Biosafety Cabinets (BSCs)

- A ventilated enclosure for work with biohazard agents assigned to biosafety levels 1 through 4.
- Provides 3 types of **<u>CONTAINMENT</u>**:
 - Personnel protection
 - Product protection
 - Environmental protection
- All BSCs contain: 1+ HEPA filters & motor/blower



BMBL, 5th Edition, 2009

Class II Type A2 BSCs

- Personnel, Product and, Environmental Protection from particulates and aerosols.
- Minimum 100 fpm intake air
- Partial recirculation



Normal BSC Operation



- 1. Strong front intake air
- 2. Side suction slots
- 3. Downward HEPA filtered air
- 4. Smoke split to front and back
- 5. Momentum Air Curtain



MYTH: Don't use heat sources in a BSC



- Theoretical reasoning:
 - The gas needed to light the flame would be dangerous flowing around the hot BSC motor.
 - Heat changes airflow dynamics within the BSC that are critical for safety.



Volatile Gas release

 Using our previous research (see Volatile Chem Use in a BSC on <u>BakerCo.com</u>), we can calculate how much propane can be released into a BSC safely without explosion *given there is no spark or excessive heat*.

 $ER(propane) = \frac{Q_i * MW * LEL * 473}{403 * SG * S_F * 100} = \frac{267 cfm * 44.1 g/mol * 2.1\% * 473}{403 * 1.52g/mL * 10 * 100}$ = 19mL/min

$$ER(natural gas) = \frac{Q_i * MW * LEL * 473}{403 * SG * S_F * 100} = \frac{267 cfm * 18 g/mol * 1\% * 473}{403 * 0.56 g/mL * 10 * 100}$$
$$= 10 mL/min$$



 Release rate of propane from a tank to a Bunsen burner = 0.12mL/min



*If there is no spark, flame, cracked gas tubing, leaky valves, etc. Still not recommended!

Volatile Gas spontaneous ignition

- Auto Ignition temperature of propane = 504°C
- Maximum motor/blower allowable temperature = 150°C





*If there is no spark, flame, cracked gas tubing, leaky valves, etc. Still not recommended!

Gas Explosion

- If you are fan of the show, you know they do the theoretical exercise, then the practical test. Here's where we try to blow up a BSC using propane and natural gas.
- We did NOT do this.
- But here are some examples of explosions:









*Flammable gasses in a BSC are NOT recommended!

Airflow disruption

- Visually
 - Smoke
- BSC performance/Containment
 - Particle Counting
 - NSF International Standard 49 Biological Testing Criteria





Sources of Heat

- Four Commonly used Heat Sources:
 - Standard Bunsen Burner
 - High Heat Bunsen Burner
 - Bacti-Cinerator
 - Spirit Lamp



BAKE

Heat Sources in a BSC

- Initial Problems:
 - Lighting a flame in a windy environment
 - Keeping it lit for the duration of the experiment





Airflow Disruptions

Upward flow of air



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Contamination Experimentation

- Tested on a 6 ft and 4 ft Class II Type A2 BSC (SterilGARD e3)
- Split work surface into zones





Note: All experiments were done with an 8" sash opening.

Particle Counting

• Can the BSC maintain ISO Class 5?



Spirit Lamp	PASS ✓
Bacti-Cinerator	PASS ✓
Bunsen Burner	FAIL X
High Heat BB	FAIL X

• Taller flames affected the Momentum Air Curtain and intake air



HEPA filters are not immune to heat

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- Microbiological aerosol testing in accordance with NSF International Standard 49 testing
- Locations A, B, C, D for Product and Personnel; B, C for Cross.



NSF 49 Pass/Fail Criteria:

Personnel ≤ 10 CFUs Impingers ≤ 5 CFUs Slit samplers Control > 300 CFUs

Product ≤ 5 CFUs Control > 300 CFUs Cross

 \leq 2 CFUs 14+" away



- Bunsen Burner
 - 6ft BSC:
 - Personnel = 4/4 PASS
 - Product = 3/4 FAIL
 - B,C,D
 - Cross = 2/2 FAIL
 - B,C
 - 4ft BSC:
 - Personnel = 3/4 FAIL
 - B,C,D
 - Product = 4/4 FAIL*
 - A, B, C*, D
 - Cross = 2/2 FAIL
 - B,C

*Major Failure







- High Heat Bunsen Burner
 - 6ft BSC:
 - Personnel = 1/4 FAIL
 - C
 - Product = 3/4 FAIL
 - A, C, D
 - Cross = 2/2 FAIL
 - B,C
 - 4ft BSC:
 - Personnel = 2/4 FAIL*
 - A, C*
 - Product = 4/4 FAIL
 - A, B, C, D
 - Cross = 2/2 FAIL
 - B,C









- Bacti-Cinerator
 - 6ft BSC:
 - Personnel = 1/4 FAIL
 - D
 - Product = 1/4 FAIL
 - A
 - Cross = 1/2 FAIL*
 - C*
 - 4ft BSC:
 - Personnel = 2/4 FAIL
 - B,D
 - Product = 4/4 FAIL
 - A, B, C, D
 - Cross = 2/2 FAIL
 - B, C

*Close to passing







- Spirit Lamp
 - 6ft BSC:
 - Personnel = 4/4 PASS
 - Product = 1/4 FAIL*
 - C*
 - Cross = 1/2 FAIL
 - C
 - 4ft BSC:
 - Personnel = 1/4 FAIL
 - D
 - Product = 2/4 FAIL
 - A, B
 - Cross = 2/2 FAIL*
 - B*, C*

*Close to passing *Major Failure







• Cross Contamination Microbiological Testing also allows you to determine a "safe zone" away from the burner.



23"

• *Spoiler:* There isn't one.



Observations of Note

- Heat built up quickly within the BSC (>10°C)
 - The worst results were seen after the burners had been on for a while
- Results were worse in the 4ft BSC vs. 6ft BSC
 - Smaller work area = less heat dissipation = greater airflow disruptions
- Aerosol generation was affected by burners
 - Flow out of the nebulizer could be seen fluctuating



Conclusions

- Heat sources in a BSC cause problems
- Major airflow disruptions
- Personnel, Product and Cross Contamination Protection are compromised
- Gas in a BSC is NOT recommended!
- WHOLE work area is affected



- Use a Burner alone on bench SAFE*✓
- Work in a BSC without a flame SAFE*
- Burner inside a BSC NOT ALWAYS SAFE X



*Given following proper procedures

Alternative Solutions

- Instead of using a flame inside a BSC:
 - 1. Segregate work to flame work on a bench, other work in BSC
 - 2. Eliminate use of a flame, try touch heat sources
 - 3. Disposable loops, sterilized toothpicks, etc.
 - 4. Reassessment of procedures



Don't be this guy \rightarrow



Upcoming BSC MythBusters

- 2+ people in a BSC?
- How much is "overloaded"?











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Help spread the word of BSC myths, and send me the ones you want busted!

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