Biological Safety Cabinets

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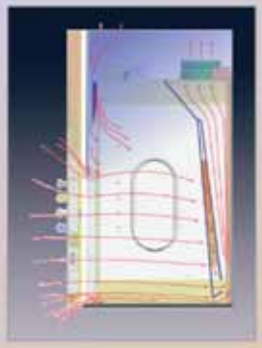
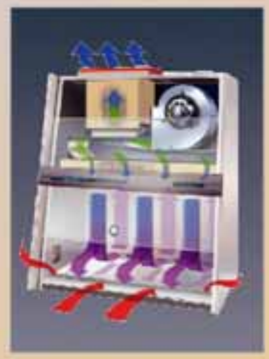
Topics:

- Theory of Operation
- Cabinet Types
- Cabinet type specification
- Industry trends

Fume Hood or Biological Safety Cabinet?



Fume Hoods - Enclosures that capture, contain and remove chemical *fumes* and *vapors.*



Biological Safety Cabinets - Enclosures that capture and contain *biohazardous aerosols* within the cabinet.

Microbiologists are very concerned about maintaining a contamination-free work area. Therefore, you will notice that a biosafety cabinet is generally cleaned daily and kept free of excessive equipment.

Chemical fume hoods, on the other hand, can often house on-going experiments for months at a time. Since there is usually not a contamination concern, little priority is placed on removing excess equipment.

In general, microbiologists work at a biosafety cabinet in a seated position. A procedure can often take several hours. Therefore, there is an emphasis on ergonomic designs of biosafety cabinets.

Chemical fume hoods often have cabinetry located below them, making it difficult to work at while sitting. For this reason, chemists are often observed standing at fume hoods.

Market Applications

Microbiology – general and academic research

Clinical – specimen processing

Cell Culture – cell growth and manipulation

Biotechnology – genetics

Pharmaceutical
– compounding and chemotherapy prep

Industrial Microbiology
– quality control & media prep

Forensics
– evidence processing

Theory of Operation

The major components in a BSC are:

- The HEPA Filter(s).
- The Motor/Blower to force air through the unit.
- A speed control for the motor/blower.
- Appropriate air intakes, ductwork, and air balance controls.

Theory of Operation

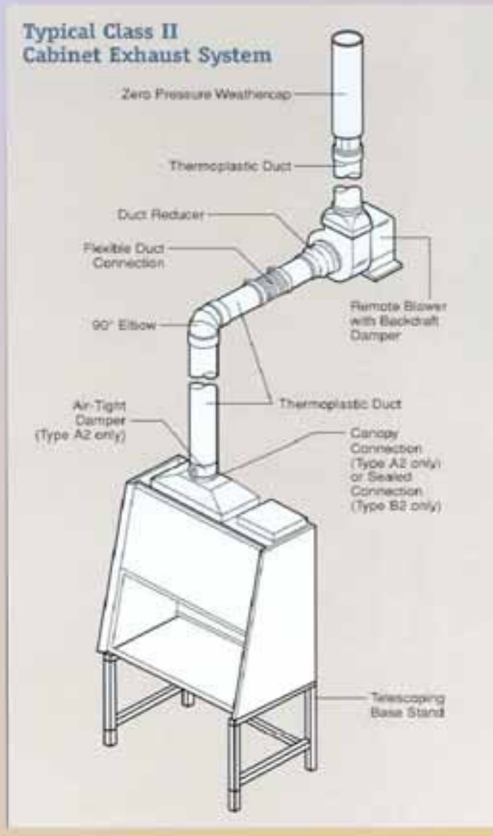
Directional Air Flow

- Air is drawn in from the front of the cabinet.
- Directional airflow into the cabinet face prevents aerosols escaping from the face of the cabinet.
- Average inflow velocity is 100-110 fpm
- (except Type A1).

Theory of Operation

Laminar Flow

- Vertical laminar airflow through the work area captures aerosols generated in the work area of the cabinet.
- True laminar airflow velocities throughout the cabinet must be 55-fpm (+/– 16-fpm).



Major components of a BSC exhaust system:

- Remote blower
- Backdraft damper
- Ductwork system
- Connection to the cabinet

Canopy Connection

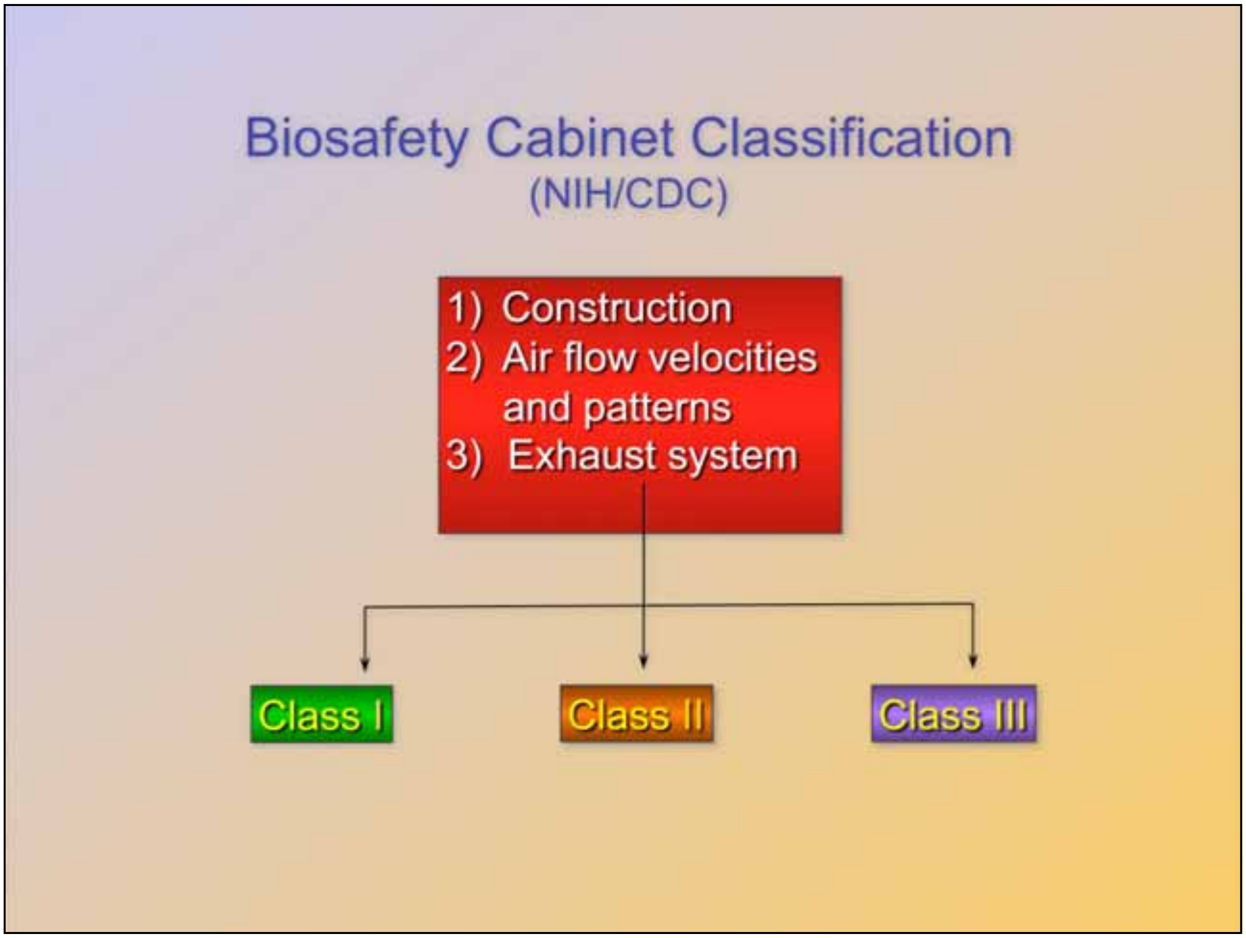
- AKA: thimble, air-gap, or loose connection
- Total exhaust volume equals cabinet exhaust plus an additional 20-25% from room

Example:

Total Exhaust		BSC exhaust		Room air
358 CFM	=	283 CFM	+	75 CFM

Remote Blower

- Pulls exhaust air through the ductwork out above the roof.
- The size of the blower will vary as the cabinet style varies.
  - Type A2: ¼ HP or less motor
    - < 0.5" w.g. static pressure
  - Type B2 – 2 HP motor
    - 1.5 – 4.0" w.g. static pressure
- Backdraft Damper - prevents air flowing backwards in the system when not operating.


Biosafety Cabinet Classification
(NIH/CDC)
1) Construction
2) Air flow velocities and patterns
3) Exhaust system
Class I
Class II
Class III

Class I

- Open front with directional airflow
- Operates under negative pressure
- Face velocity of 75-100 fpm
- HEPA filtered exhaust
- For work requiring Biosafety Level 1, 2, or 3 containment
- Provides personnel and environmental protection only

HEPA Filtered Air

Room Air

Contaminated Air

* Defined By NIH/CDC

Class II

- Open front with directional airflow for personnel protection
- HEPA-filtered laminar downflow for product protection
- HEPA-filtered exhaust
- Face velocity of 75-100 fpm
- For work requiring Biosafety Level 1, 2, or 3 containment
- Provides personnel, product and environmental protection

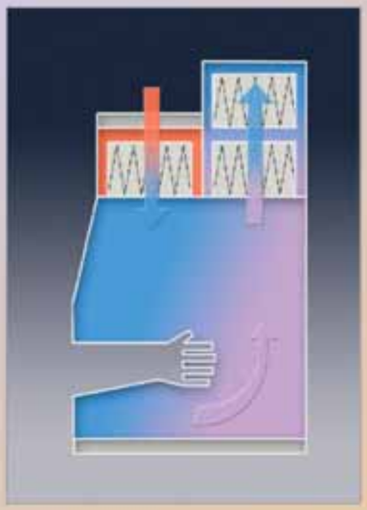
Contaminated air under negative pressure
Contaminated air under positive pressure
HEPA-filtered air
Room air

* Defined By NIH/CDC

Technically speaking Class I, II, and III are all forms of biosafety cabinets, but the Class II is the most common.

The terms biological safety cabinet and biosafety cabinet are generally used to describe the Class II cabinet. This equipment is the topic for this presentation.

Class III

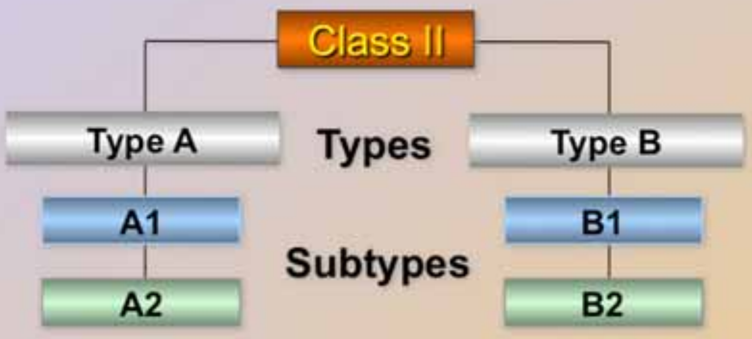


- Totally enclosed
- Gas tight construction
- Work through gloves
- Negative pressure of at least 0.5" H_2O
- Double HEPA filter exhaust
- For work requiring Biosafety Level 1, 2, 3, or 4 containment
- Provides personnel, product and environmental protection

Contaminated air under negative pressure
HEPA-filtered air
Room air

* Defined By NIH/CDC

NSF/ANSI 49 Standard



Differences between Type A and Type B Biological Safety Cabinets

Class II

Type A	Type B
No "exposed" contaminated positive pressure plenums allowed	No "exposed" contaminated positive pressure plenums allowed
Minimum average face velocity: 75 fpm – Type A1 100 fpm – Type A2	Minimum average face velocity: 100 fpm
Exhaust into lab or outside via canopy connection	Must exhaust outside the lab via dedicated exhaust system with alarm

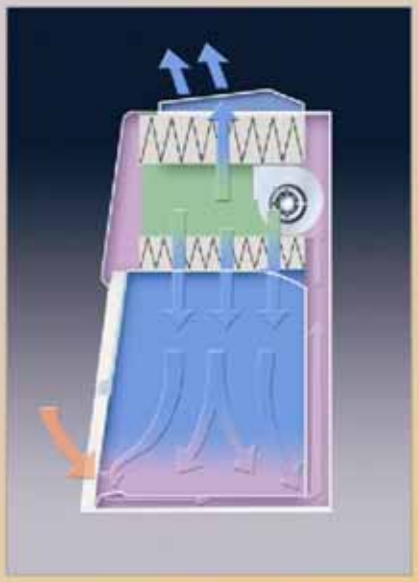
Type A2 Cabinets

HEPA Filtered Air

Room Air

Contaminated Air

Minimum Inflow = 100 fpm



Biosafety Levels 1, 2, & 3

No radionuclides

No volatile toxic chemicals

Open flames not recommended

Type B2 Cabinets

HEPA Filtered Air

Room Air

Contaminated Air

Minimum Inflow = 100 fpm

Biosafety Levels 1, 2, & 3

Radionuclides OK*

volatile toxic chemicals OK*

Open flames not recommended

** When used as an adjunct to microbiological research*

Biological Safety Cabinet Airflow Configurations

Without Canopy

Type A2

Canopy Connection

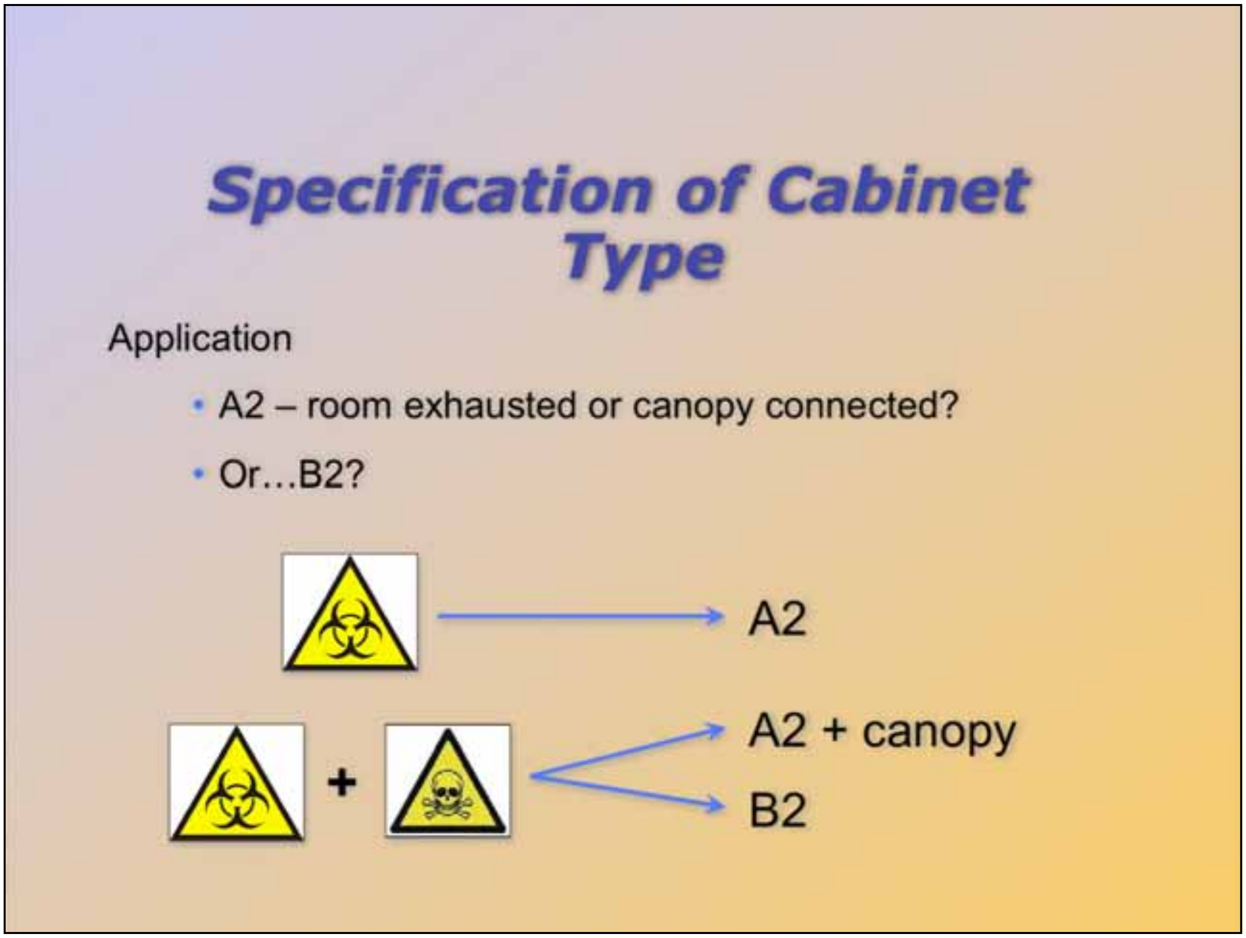
Type A2

Sealed Connection

Type B2

B2 or not B2…
That is the Question

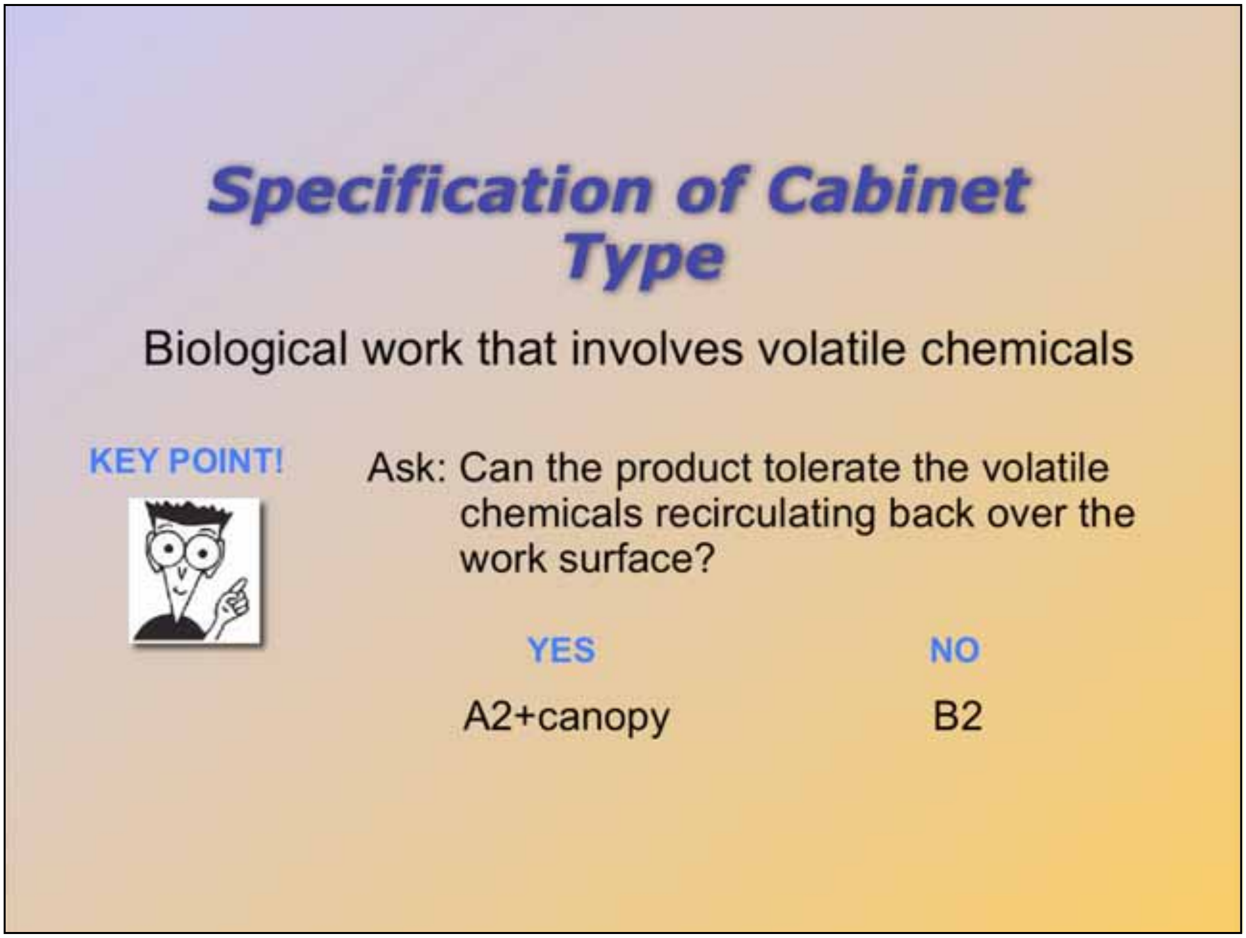
Let us address when to use a Type B2 cabinet versus a Type A2 cabinet.



For routine microbiological work, a Type A2 is sufficient. In this scenario, it is preferable to exhaust the cabinet back into the lab.

When volatile toxic chemicals or radionuclides are used in conjunction with microbiological work, the cabinet should be ducted to a remote exhaust system.

If nuisance odors are generated by the work, then a carbon post-filter or duct connection can be used. The carbon post-filter will allow the A2 to exhaust to the room, by removing the odor.



<u>If we know that we need to duct, then we need to answer the above question.</u>

This is the point where it is often mistakenly assumed that we must go straight to the B2.

Specification of Cabinet Type

	Type A2	Type B2
Biological Containment	EQUAL	
Exhaust System	Optional	Required
Exhaust System	May be ganged w/ other A2	Dedicated exhaust recommended
Exhaust Volume	~30%	100%
Exhaust Blower Static Pressure Capacity	~0.5" w.g. (constant)	Up to 4.0" w.g. (increases as filter loads)
Cabinet Flexibility	Can be disconnected from exhaust	Permanently connected to exhaust
Cabinet Cost	$$	$$$$$
Installation Cost	Recirculating - $ Canopy - $$$$	$$$$$
Tempered Air Cost	Recirculating – 0 Canopy - $$	$$$$$

The above chart outlines some very good reasons NOT to use a B2…if it can be avoided. B2 cabinets are more expensive and far less efficient!

Of course if the B2 is right for the application, then this is what should be used.

Selecting the Proper Biological Safety Cabinet

Primary Consideration - **Application**

Safety Considerations

- Type of protection required –
  - product only
  - personnel and environment only
  - or all three
- Type and quantity of volatile toxic chemicals used

Operational Considerations

- Size of cabinet
- Proper location for the cabinet
- Type of exhaust system needed
- Accessories for the cabinet

Selecting the Proper Biological Safety Cabinet

Secondary Consideration - **Cost**

The TOTAL Capital costs

- Cabinet
- Remote blower
- Ductwork
- Other hardware

The TOTAL Installation costs

- Cabinet
- Modifying the laboratory (walls, ceilings, ventilation)
- Exhaust system
- Hardware

Selecting the Proper Biological Safety Cabinet

Secondary Consideration - **Cost**

The TOTAL Operating costs

- Air conditioning and heating losses
  - Type B cabinets are less efficient
- Supplying make-up air to lab
- Electrical power

The TOTAL Maintenance costs

- Certification costs
- Service, especially HEPA filter replacement

Selecting the Proper Biological Safety Cabinet

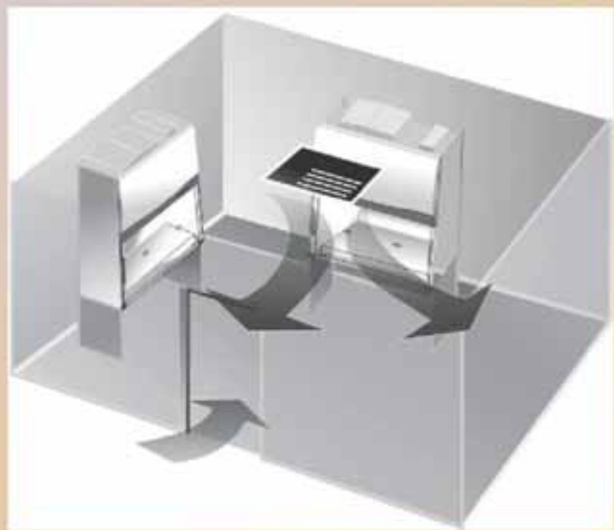
Tertiary Considerations – **Options & Accessories**

- The width of the cabinet required
- Service Fixtures
- Electrical Receptacles
- UV Lights
- IV Bars
- Base Stand

Location of a Biosafety Cabinet

Avoid:

- Cross drafts and airflow fluctuations in front of cabinet
- High traffic areas
- Low ceiling clearance
- Limited side-panel access



As described in NSF/ANSI 49

Trends in Biological Safety Cabinets

Energy Efficiency

- Reduced electricity consumption
- Cooler operation
- Quieter operation

Cabinet performance

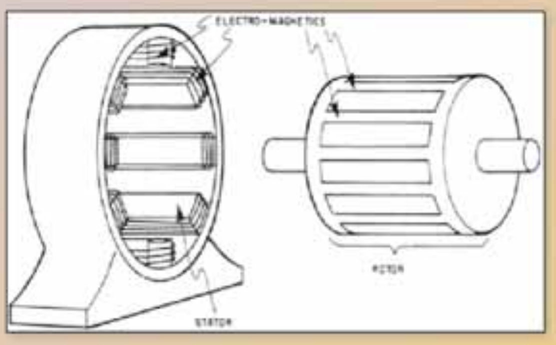
- Automatic motor speed compensation
- Filter performance feedback
- Digital displays
- Visual alarm feedback

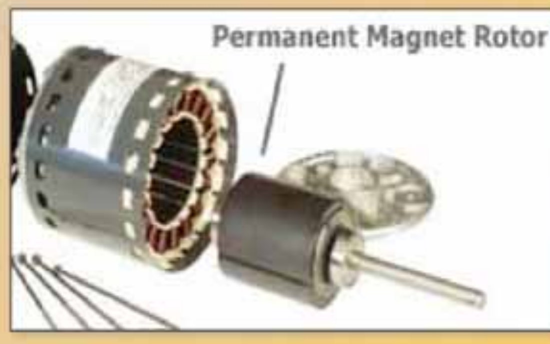
Energy Efficiency

Power Consumption (Watts)*

	4-ft BSC	6-ft BSC
PSC motor	582	1440
3-phase motor	480	804
Brushless DC motor	290	490

* 120V / 60 Hz

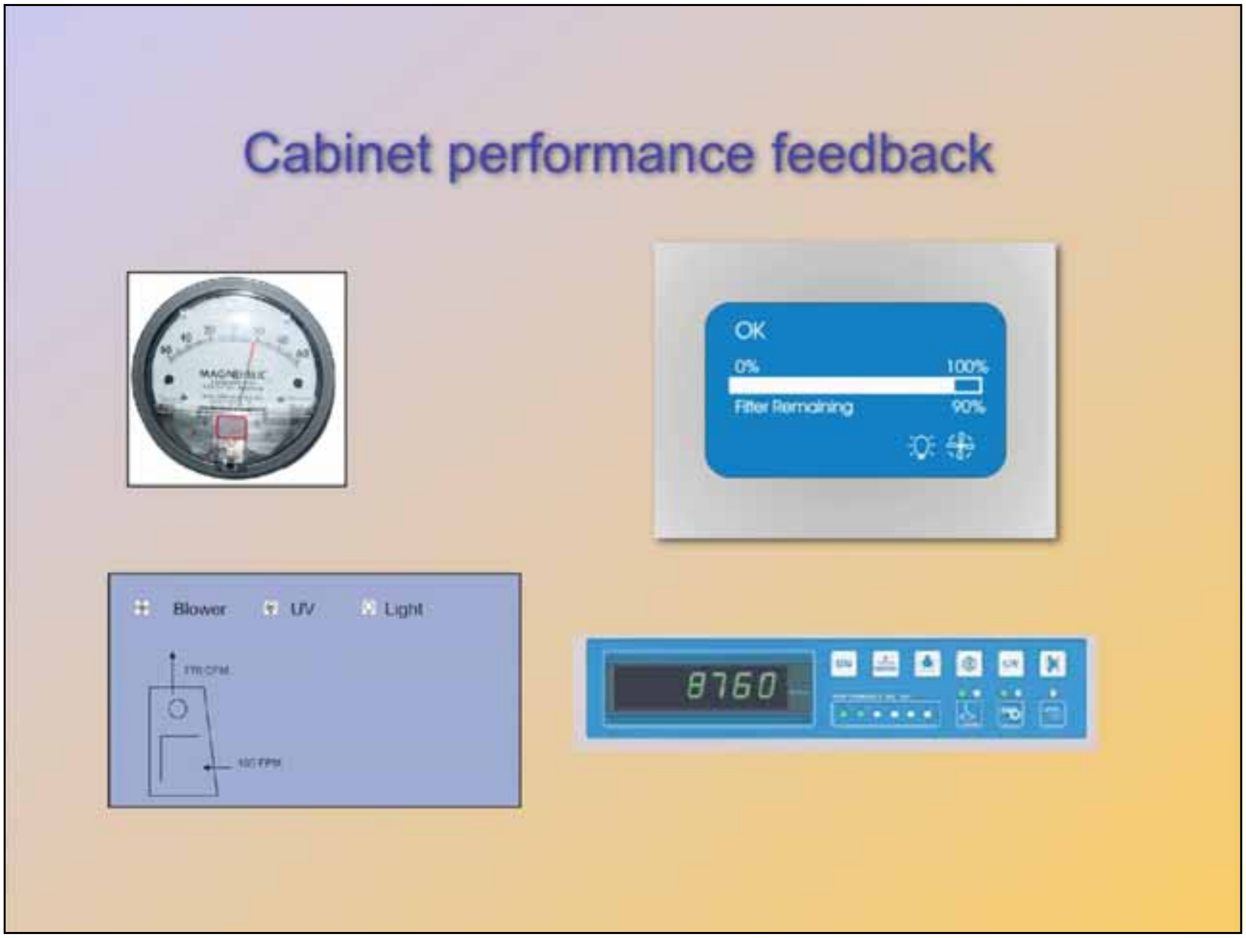




In a PSC motor, the magnetic field must be induced. This generates a large amount of waste heat and significantly reduces the motor's efficiency.

New motor technologies run much more efficiently. In reality, these "new" motor designs are not new at all. Yet, only recently, did the biosafety cabinet industry begin taking advantage of this motor technology.

The Brushless DC motor, for example, has been used for well over a decade for high-end commercial and residential HVAC blowers. It is also the same motor design in your computer's hard drive and disk drive, as well as the fan cooling the processor.



Biosafety cabinet manufacturers are introducing better technology to display how the cabinet is performing.

Old technology utilized a magnahelic gauge to measure differential pressure between pressurized and non-pressurized sides of the filters. This method did not provide the user with a clear understanding of whether or not the cabinet was operating in a safe manner. In fact, most users only knew if there is a problem when the needle of the gauge moved to one extreme or the other (positive or negative).

New technology allows users to monitor the filter life of the HEPA filters, as well as the air flow volume and velocity. New biosafety cabinet designs incorporate real-time automatic adjustment of motor speed to maintain proper air flow.

Market research indicates that biosafety cabinet users find this information much more helpful and intuitive.

References

For Labconco:

www.labconco.com

For NSF :

www.nsf.org

For Controlled Environment Testing Association:

www.cetainternational.org

For all things biosafety:

www.absa.org

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