Quality Control

BALANCE ENCLOSURES

A Balance Enclosure Primer

Engineering improvements yield balance enclosure designs that improve airflow while reducing static | BY **GARY ROEPKE**

Balance enclosure engineering allows pharmaceutical lab technicians to breathe a little easier. For those who routinely weigh toxic and potentially carcinogenic powdered substances, minimizing the risk of exposure has always involved a combination of technique and technology. Optimum handling and measuring practices go hand in hand with reliable containment equipment to provide the highest level of protection.

Prudent work practices eliminate many risks and should always be foremost in reducing exposure. But advancements in containment equipment design are helping to raise the safety bar.

Current balance enclosure designs incorporate the following features:

- Safe operation at face velocities as low as 60 feet per minute (fpm);
- Glass and metal construction to minimize electrostatics;
- Interior dimensions that accommodate large balances and equipment; and
- Bag-in/bag-out HEPA filter disposal.

Some manufacturers verify enclosure performance with independent testing to provide an added level of confidence.

Process-Specific Design

More than a decade ago, balance enclosures were introduced to address the shortcomings of traditional fume hoods. Designed for pharmaceutical, biotech, and drug compounding laboratories, balance enclosures provide maximum containment of airborne particles during weighing procedures. Design objectives include the following:

Smaller dimensions. Because balance enclosures are designed for weighing operations, they do not require the height or width of a traditional fume hood. Balance enclosures are as small as two feet wide, considerably smaller than fume hoods, which are usually a minimum of four feet wide. In addition, the sash opening is generally of a smaller fixed height. As a result, these enclosures offer greater installation flexibility, require less bench space, and use less energy.

Filtration. Balance enclosures may use HEPA, carbon, or a combination of filters to remove toxic particles and gaseous contaminants from the exhaust air. Many of these enclosures duct the filtered exhaust air back into the laboratory instead of to the outside, thus saving energy and installation costs.

Lower face velocities. To reduce the influence of airflow on sensitive balances, manufacturers recommend that balance enclosures be operated with a face velocity of 60 to 75 fpm. By comparison, a typical fume hood operates at 100 fpm. Besides causing less air turbulence, lower face velocities reduce the volume of air exhausted from the laboratory, thus saving energy.

Limited electrical and plumbing requirements. Utility services, lighting, and electrical outlets aren't generally found on balance enclosures because such services as gas and water are usually unnecessary for powder weighing operations. Consequently, installation is less complicated and expensive than for traditional fume hoods.

Select a Containment System

Users should consider the following features when they evaluate containment equipment:

Aerodynamic components, including air foils at work level and along the sides, create a protective air barrier between user and contaminants and minimize air turbulence.

A rear baffle counteracts the tendency of airflow in the interior to roll forward, reducing the potential for high concentrations of contaminants behind the sash and in proximity to the user's breathing zone.

Solid construction. Glass, epoxy-coated steel, and steel frameworks withstand exposure to many compounds and cleaning solvents. Unlike acrylic, glass dissipates static; resists scratching, crazing, and discoloration from chemical exposure; and simplifies cleaning.

Dimensions that accommodate analytical balances and test equipment. For maximum containment benefits, balances and equipment should fit well within the interior of the enclosure. Appropriate dimensions make weighing procedures simpler and more efficient and provide additional safety for workers.

Safe HEPA filter disposal. Balance enclosures with built-in HEPA filters should provide a means for the user to safely remove and replace the filter when it becomes loaded. Some enclosures include a bag-in/bag-out system that allows a technician to remove the contaminated filter without exposing personnel or the environment to the filter or to other contaminated components.

Verified performance. Manufacturers should provide test results showing that the enclosure meets performance specs. Testing done by third-party consultants adds credibility to these claims. Tests include fume containment (ASHRAE 110-1995), powder containment, and balance stability.

Performance Considerations

Even with the many advantages of balance enclosures, tradeoffs exist. A variety of conditions affect the ability of the equipment to provide accurate weighing and containment while promoting worker safety.

Static. Static electricity negatively affects weighing operations in several ways. First, it exerts a force, affecting balance precision. Second, static can result in loss of sample or in inaccurate readings if the sample clings to the apparatus or enclosure. Third, static can be a safety concern if hazardous powders that cling to the surfaces of the enclosure are left behind when the enclosure is not operating. Finally, static can lead to cross contamination of samples if a sample is left behind.

Combining safe work practices with the containment of balance enclosures is safest for lab workers.

Low humidity and lab furnishings constructed of materials with high surface resistivity may be sources of static (Table 1). Air impurities impinging upon surfaces dictate the polarity and magnitude of the electrostatic charge.

The ability of a material to become polarized is a property known as permittivity. On such highly insulative materials as acrylic, ions or charged molecules are strongly bound to the surface by polarized forces. The higher the force, the higher the permittivity value of the material. High permittivity materials, such as plastic, hinder the accuracy of the balance. Because static electricity is a surface phenomenon, materials can also be classified by their surface resistivity, measured in ohms per square.

Table 1. Surface resistivity figures for various classes of material. Glass and metal have less surface resistivity than acrylic

SURFACE RESISTIVITY

MATERIAL	SURFACE RESISTIVITY	EXAMPLE
Conductive	$0–10^5$ ohms per square	Skin, metals
Static dissipative	$10^5–10^9$ ohms per square	Glass
Antistatic	$10^9–10^{12}$ ohms per square	Polyethylene bag
Insulation	$\geq 10^{12}$ ohms per square	Acrylic box, packing foam

Vibration. Balances are sensitive to vibration. Vibration can stem from instability in the supporting base, in surrounding laboratory equipment, from the balance enclosure itself, or even from placement in the building. Advanced balance designs improve performance by countering some of these effects. Marble, granite, or epoxy balance slabs provide additional protection from vibration.

Exhaust system performance. Several standards provide guidelines regarding exhaust system performance for lab enclosures. These standards include Federal Register 29 CFR Part 1910, published by the Occupational Safety and Health Administration, U.S. Department of Labor; *Industrial Ventilation: A Manual of Recommended Practice,* published by the American Conference of Governmental Industrial Hygienists; ANSI Z9.5-2003, published by the American Industrial Hygiene Association; and SEFA 1-2005 Laboratory Fume Hood Recommended Practices, published by the Scientific Equipment and Furniture Association.

Although dependent on application and safety officer recommendation, balance enclosures are most commonly operated at 60 to 75 fpm. Options to connect to the house exhaust system or filters depend on the properties of the materials being weighed and on room design.

Operator practices and techniques. Although balance enclosures greatly reduce workers' risk of exposure, the training and work practices of professionals using balance enclosures must be designed to minimize worker exposure. Sloppy technique resulting in spillage, for example, increases a worker's chance for exposure. ANSI/AIHA Z9.5 recommends prudent work practices to contain toxic agents in the laboratory. Ultimately, combining safe work practices with the containment protection

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of balance enclosures is safest for laboratory workers.

THE WORKHORSE FUME HOOD

Laboratory fume hoods have long provided a safe ventilated environment for handling gaseous contaminants. These enclosures contain toxic vapors and fumes, direct airflow away from the operator, and remove contaminants through an exhaust system. Fume hoods are powered by exhaust blowers that pull air from the laboratory room into the hood. In the hood work area, contaminated air is diluted with room air before the air is exhausted to the outside. When used properly, fume hoods effectively contain hazardous fumes and minimize worker contact with potentially harmful substances.

> The higher velocities and volumes required to remove contaminated air increase the probability that balances, instruments, fragile apparatus, and the materials being measured will be disturbed.

Fume hoods are less effective, however, in meeting the requirements of users measuring fine toxic powders, which have a propensity to become airborne. The higher velocities and volumes required to effectively remove contaminated air increase the probability that balances, instruments, fragile apparatus, and the materials being measured will be disturbed.

Fume hoods also offer little environmental protection from particle contamination. Typical hoods exhaust air via ductwork to the outside, where fumes and vapors are diluted to acceptable levels of concentration. For toxic powders, ANSI/AIHA Z9.5 guidelines require a secondary air-cleaning device for particle contamination. ■

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