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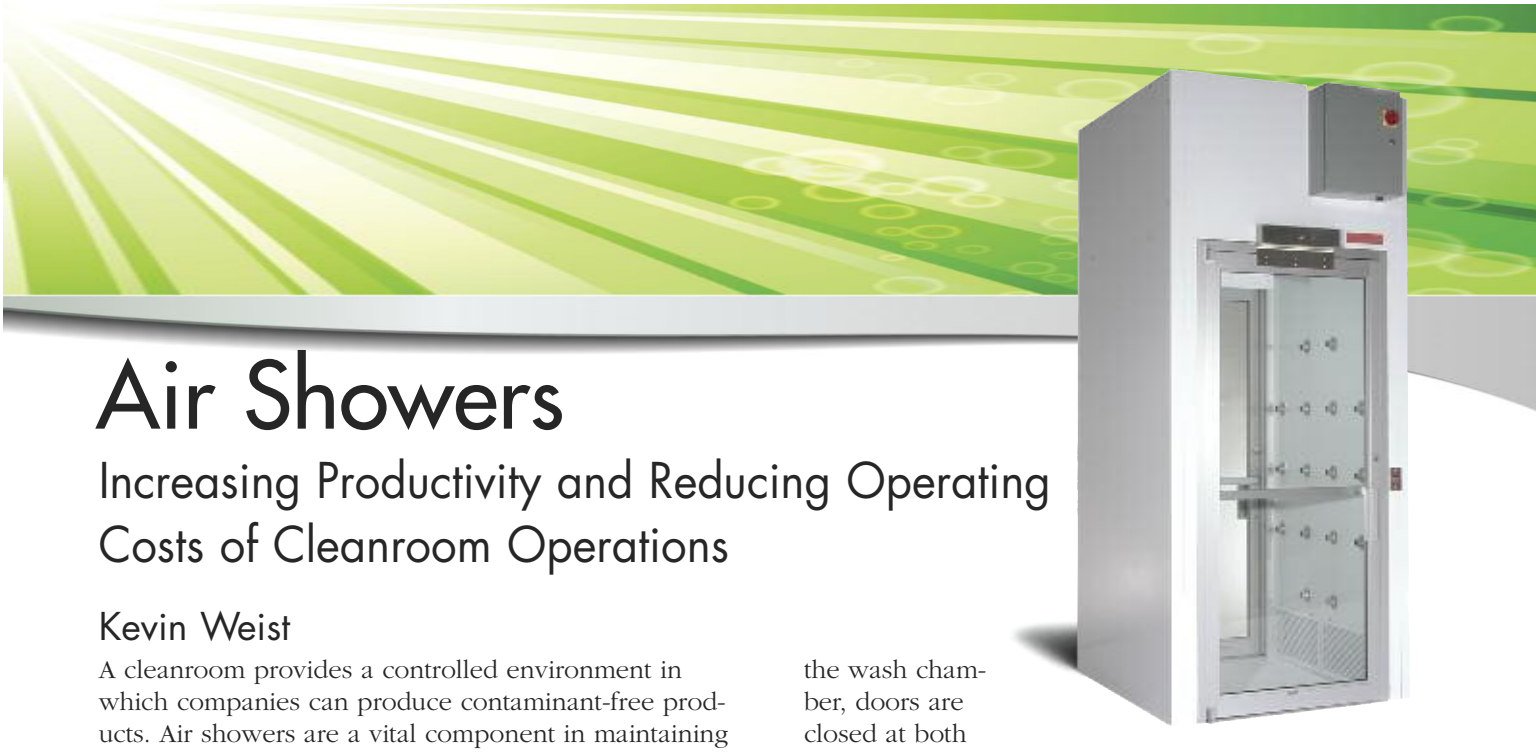

Air Showers

Increasing Productivity and Reducing Operating Costs of Cleanroom Operations

Kevin Weist

A cleanroom provides a controlled environment in which companies can produce contaminant-free products. Air showers are a vital component in maintaining that clean environment. They protect the cleanroom by using high velocity jets of air to remove loose particles of contamination from people and products before entering, thereby reducing product defects and increasing production yields. The cleanroom itself will require less maintenance because the contamination load, or build up, will be at a lower level. Cleanroom high efficiency particulate arresting (HEPA) filters are going to last longer because of the air shower system. Without the pre-cleaning performed by air showers, the main cleanroom air filtration system would absorb the entire contamination load, resulting in increased energy consumption and maintenance costs.

Air showers are self-contained air recirculation systems installed at entrances to cleanrooms and other controlled environments to reduce cleanroom contamination as workers enter the clean production space. Their operation is similar to a pressure washer system at an automated car wash. For example, a car enters the wash chamber, doors are closed at both ends, and high pressure streams of water from all angles blast particles of dirt from the car. The cleaning cycle ends, a light comes on, and the exit door opens. With the air shower, a worker passes through the entry door and a sensor activates interlock magnets which then close the door. High velocity streams of Class 100 filtered air, from a large number of precisely placed, adjustable nozzles or vertical slots, is blown onto workers as they raise their arms and rotate in place. The high velocity air creates a flapping effect on the workers' clothing which produces a "scrubbing" action, removing particulates from their cleanroom garments. Indicator lights then signal the end of the cleaning cycle, and the cleanroom door is opened. Typically, it takes about four to eight seconds of cleaning time and then another two to four seconds for the blower to wind down and give the air shower time to purge the contaminated air prior

to the worker exiting. Adjustable microprocessors control the cleaning and wait times.

People are the main source of cleanroom contamination, and anyone entering a cleanroom must follow preparation procedures to reduce the amount of contamination. Depending on cleanroom cleanliness requirements, workers will put on a full cleanroom suit which covers nearly the entire body, or just a gown and cap or hood over their street clothes. Air showers are an essential final cleaning step before entering a cleanroom because the "gowning" process disturbs and releases contaminants from street clothes that can settle onto the "clean" garments. Special garments made from smooth-surface synthetic materials such as Tyvek® and GORE-TEX® are designed to minimize the mechanical bond of particulates and easily shed contaminants. Natural fiber materials such as cotton or wool tend to have rough surfaces, producing a high mechanical bond with particles, making them difficult to clean. Air showers allow cleanroom garments to be used multiple times before a thorough cleaning is necessary, further lowering overall operation costs.

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The intent of an air shower is to quickly and efficiently clean particulate contaminants from workers before entering a clean space. Power and capacity are the two factors that influence the effectiveness of an air shower. Cleaning power is determined by nozzle velocity and can be described as the speed in which air is pushed through the nozzles. It takes high velocity air to dislodge particulate contamination, and the higher the velocity or cleaning force, the more effectively the contamination can be removed. Capacity is the volume of air circulated in the system. More air volume means faster cleaning and removal of contamination through the filtration and recirculation system.

The most effective air shower units produce nozzle velocities of 7,800 feet per minute (fpm) and circulate 1,900 cubic feet per minute (cfm) of air. Velocity is measured at the nozzle, and the cleaning effectiveness deteriorates as the workers' distance from the nozzle increases. Therefore, to be most effective, air showers should have a high number of air nozzles and be positioned as close to the workers as possible. Typically, the space between nozzles on opposite air shower walls is about 36 inches and standing between nozzles, an average-sized worker will be positioned about eight inches away from any one nozzle. At that distance, the worker is experiencing air velocity in the 6,500 to 7,000 fpm range, which is still an effective cleaning force.

Similar in design to an air lock, air showers typically have two doors that cannot be opened at the same time—accommodating only one person at a time. Workers enter one side and exit on the opposite side. When one door is opened, the other door's magnet is energized which prevents the door from opening. During the cleaning cycle, both doors are energized (locked) to prevent anyone from entering or leaving before the cycle is completed. Typically, emergency power off (EPO) buttons are available on internal and external walls if door interlocks are installed.

Air shower designs range from a single batch system where one person uses the shower at a time, to a tunnel-like system for larger groups to pass through quickly. The size of the unit is usually determined by the number of people that need to enter a cleanroom in a given time. Tunnels are becoming more common because of the amount of cycle time needed for a 30- or 40-person shift change.

Most air showers are modular and can be configured in various sizes and shapes to fulfill specific customer requirements. The straight-through design, with nozzles on two opposing walls, cleans workers with more ease.

However, depending on space or facility requirements, a 90-degree design can be used where users enter on one side and exit to the right or left at a 90-degree angle. This configuration does not have the same number of air nozzles as the straight-through design and requires the worker to turn 360 degrees during the cleaning cycle to ensure sufficient cleaning before leaving the chamber. Other designs may have double doors or even three doors for entry and exit.

Structure materials are typically stainless steel, painted steel, or laminated particle board. Most air shower shells are constructed of steel and painted with a strong, durable cleanroom-compatible finish. For some medical, pharmaceutical, or extremely wet environments stainless steel construction is ideal. Some manufacturers offer economy units made of laminated particleboard, but due to possible temperature and humidity fluctuations this type of construction is subject to de-lamination, easy physical damage, and joint loosening, all of which may generate particulate or biological contamination.

The air shower's recirculating air filtration systems typically use two sets of filters. The first is a pre-filter for catching the bulk of contaminants, and the second is a high-capacity, 99.97% efficient HEPA filter. System blower units are mounted in the ceiling, or if there are facility height restrictions, they can be mounted on the external wall. All routine maintenance is done from the inside, with the pre-filters changed on a regular basis.

When selecting an effective air shower system, the following should be considered:

- System should be modular, allowing for easy configuration, shipment, and assembly
- Shell should be made of stainless or painted steel
- Blower system must supply high velocity, high volume air
- Recirculating filtration system should use pre-filters, followed by high-capacity HEPA filters
- Units should have a high number of adjustable, evenly spaced air nozzles
- Unit should have magnetic door interlock systems with appropriate controls

Whether ensuring high semiconductor yields or a flawless paint finish, a wide variety of industries use air showers as part of their cleanroom operation. Semiconductor, medical device, bio-tech, microelectronic, optics, pharmaceutical, aerospace, nanotechnology, and automotive industries require contaminant-free environments and commonly use air showers as part of their operation.

While air showers are typically used for cleaning gowned personnel before entering a clean environment, they can also be used to remove particulates as workers leave hazardous work areas before going out into the general public, or preventing cross contamination when moving from one work space into another.

Air showers are just one, but a very important, factor in ensuring good cleanroom performance. Proper worker training, documented procedures, and a well-maintained system will increase production yields and reduce product defects and costs.

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