WEISS PAPER

WEISS PHARMATECHNIK - COMPACT KNOWLEDGE

DOWNFLOW SYSTEMS

Downflow systems are available based on the laminar flow or, alternatively, the barrier flow principle for efficient product, personnel and environmental protection.

Energy and work efficiency for downflow systems.

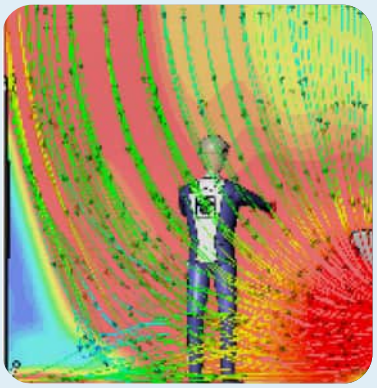
When is it worthwhile to use the barrier flow principle?

Various aspects must be taken into account when deciding on the optimal downflow system to protect sensitive products from contamination or operating personnel from health risks when handling potentially hazardous substances.

Selecting a suitable technology involves considering not only the space requirements and potential applications of the systems, but also their energy requirements. Considerable differences exist here depending on the area of application. Compared to downflow systems based on the laminar flow principle, barrier flow systems offer energy savings of up to 50%. Barrier systems also feature a more compact design and improved accessibility to the work area.

What contamination protection systems are available?

The equipment and technologies used to handle sensitive or hazardous substances vary considerably. Systems differ in terms of access: for example, whether they should be accessible on foot or by vehicle, or whether a reach-in kiosk concept is desired. The ventilation technology design depends on the system's protective purpose: Is the sole purpose to implement a product protection concept to prevent product contamination, or is the focus on protecting operating personnel and the environment? Often, both requirements must be met simultaneously.



The smaller the diffuse zone (blue) in the front area, the better for the usable area and protective effect.

Usable area as a key parameter.

A decisive performance criterion when comparing different downflow systems is energy efficiency, i.e., the ratio of power requirement to the usable area of the system below the outflow surface. Systems of different technologies differ considerably, particularly regarding the usable area. Due to the special air guidance concept, barrier flow technology increases the usable area by approximately one third compared to systems based on the classic laminar flow concept. If both systems have a similar footprint, the increased usable area of barrier flow technology, which is about 80% of the floor area compared to 60% with laminar flow, can lead to a 50% increase in energy efficiency.

The following considers walk-in or drive-in downflow systems, which are used for various applications, such as transferring larger containers (drums, sacks, big bags, and IBCs), as well as weighing and sampling. Depending on the required process, an air cleanliness of ISO 5 and a safety level up to OEB 4 can be achieved.

The term „downflow" refers to the airflow that moves from the top down. Two different downflow concepts should be considered here: the laminar flow principle (also called UDAF, or Uni-Directional Air Flow) and the air curtain or barrier principle. Both technologies follow the downflow principle and are equally suitable for any product protection as well as personnel/environmental protection, and are characterized by individual advantages. The biggest difference between the two concepts lies in the flow profile generated below the discharge area, which with Barrier Flow can lead to an enlarged usable area.

The Laminar Flow Principle

With the Laminar Flow or UDAF principle (Uni-Directional Air Flow), the air flows uniformly and directionally with a constant air velocity of nominally 0.45 m/s (0.36 m/s - 0.54 m/s) from top to bottom from the ceiling area.

Ideally, this occurs without turbulence and swirls. The product is thus uniformly flowed over with clean air. Any product emissions are directed into the system's floor area and, if necessary, extracted to prevent inhalation by personnel. To improve air guidance, lateral „walls," typically strip curtains, are often necessary. In many cases, the front area is also limited, through which access usually occurs.

The Barrier Flow Principle

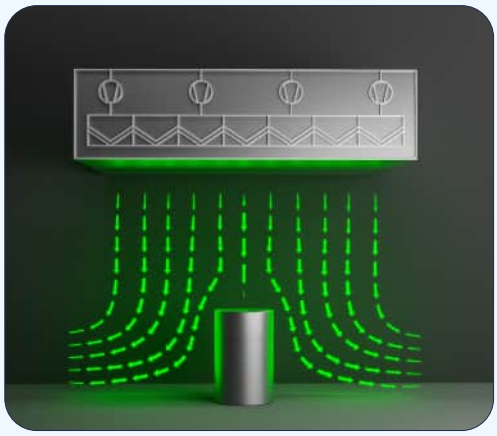
Barrier technology ensures unidirectional and uniform airflow from top to bottom. Unlike the laminar flow system, however, there is no uniform discharge velocity; rather, there is an optimized velocity profile from the back of the ceiling area to the front.

This achieves an improved protective effect. A fast-flowing air curtain, also known as a clean air curtain or barrier, is formed in the front area, which creates a sharper separation of the work area. Unlike laminar flow systems, an additional barrier in the front area is not necessary here since the clean air curtain in the front area significantly reduces the diffuse zone, where outside air mixes with the equipment air. This significantly improves room protection while enlarging the usable work area of the system in which safe work can be performed. Without the front area separation required by the laminar flow principle, such as with a strip curtain, the work area is much more easily accessible, and working inside is much more comfortable.

Good to know:
Downflow systems offer effective protection for products, personnel, and the environment through targeted air guidance, with the option of the laminar or barrier flow principle.

System Technology for Product Protection Applications

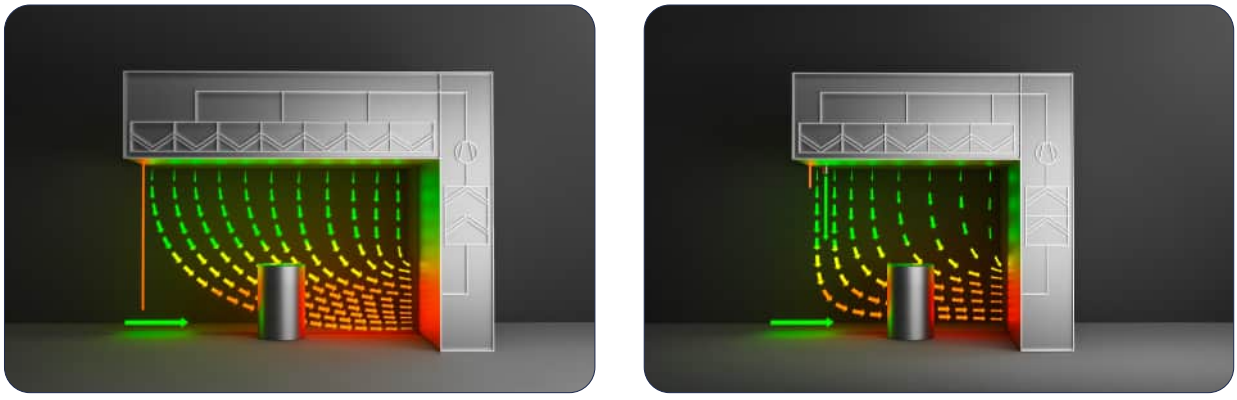
Both downflow systems, i.e., laminar flow and barrier flow principle, are outstandingly suitable for ensuring perfect product protection conditions.



The clean air emerging from the hood area of the system flows evenly over the product from above and then typically distributes in the surrounding area. The essential criterion is to achieve a laminar, directed flow velocity at the product to prevent other airflows and the entry of particles. Systems for pure product protection merely require a supply air filter, which is usually designed as a surface-mounted terminal filter. When used for pure product protection, the two systems in this example differ only slightly in the functional data. The power requirement for the laminar flow system is somewhat lower due to a slightly lower air volume requirement.

System Technology for the Protection of Personnel, Environment and Product

As with pure product protection, the air flows evenly over the product from above and does not disperse randomly in the environment. Personnel and environmental protection systems have extraction technology in the back wall to guide the contaminated air close to the floor into a mostly multi-stage exhaust air filter system. In addition to achieving laminar and directed flow velocity at the product, the essential criteria here are the complete capture of emissions and their removal into the exhaust air filters.



Side view of air guidance: *left shows the laminar flow system with front separation, right shows the barrier flow system with barrier curtain instead of a physical separation.*

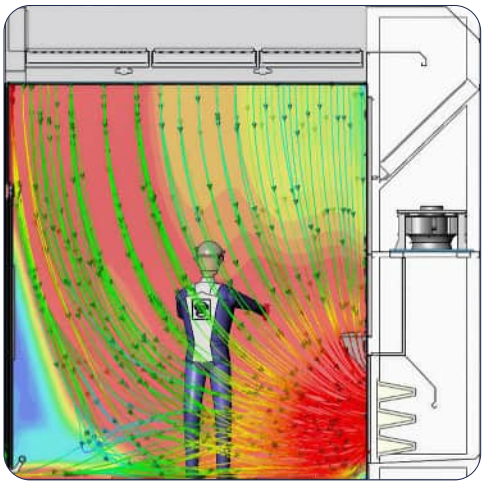
Due to the special flow pattern of barrier technology, which features a fast-flowing clean air curtain in the front area, the usable area below the discharge area is significantly larger than that of the laminar flow system. With the laminar flow system, significantly larger areas with lower air velocity and reduced product and personnel protection result due to flow conditions.

Flow Areas of a Barrier Flow System

The protection system of a WIBObarrier flow system works with an air curtain technology in which there are essentially two distinct flow areas:

1. The unidirectional flow from the ceiling field with a flow gradient, i.e., an air speed increasing from back to front.
2. The front area of the system with an additional air curtain with the highest outflow speed.

The WIBObarrier Flow can enable environmental and operator protection up to an OEB Class 4 and exhibits a maximum usable work area below the outflow surface. Since no separation in the form of a strip curtain or pane is required on the front, access for bringing in containers is also very convenient and comfortable.



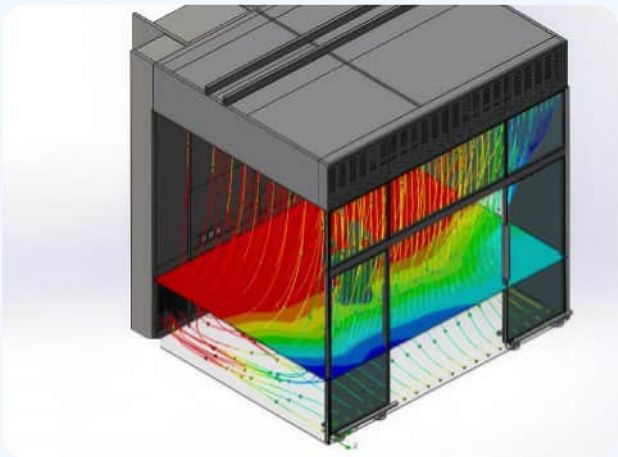
Flow pattern in a WIBObarrier Flow system.

The diffuse zone in the front area (blue) is limited here to just 300 mm. In classic laminar flow systems, the area at 800 mm is significantly larger and considerably restricts the usable area. The usable area for laminar flow systems at usage height is approximately 60% of the air outlet surface; for WIBObarrier systems it is approximately 80%. With the same system footprint, this results in a significantly larger usable workspace.

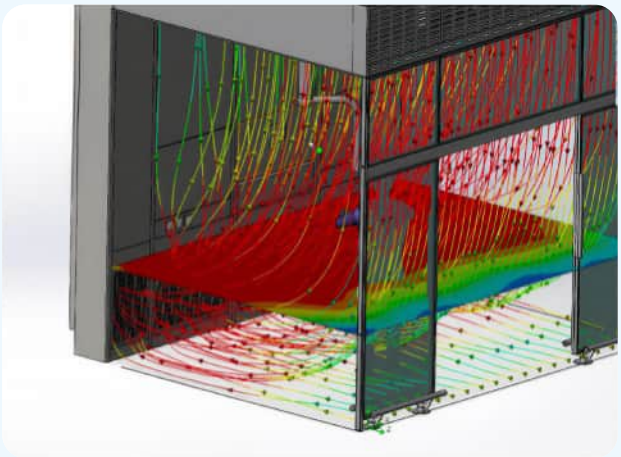
Flow simulation:

Consideration of the Effective Usable Area

The following illustrations show the flow simulations of both systems. The effective usable work area, in which the flow speed according to GMP Annex 1 is more than 0.45 m/s, serves as the reference benchmark. In the red area, which is defined as the usable area, the flow speed lies above 0.45 m/s



Flow simulation of a classic laminar flow system



In comparison, the flow simulation of the barrier flow system

Comparison of the energy requirement for product and environmental protection applications.

The protection system of a WIBObarrier flow system works with an air curtain technology in which there are essentially two distinct flow areas.

To compare the energy requirements of the different concepts, one assumes that the systems have a similarly large usable area. For this purpose, a larger footprint of the system must be calculated for a laminar flow system to obtain a comparable usable area as with barrier flow
.
Since the WIBO Barrier Flow has a smaller footprint, the required air volume flow is reduced by approximately 23% compared to a classic laminar flow system. This has decisive advantages for designing the fans and filter technology, resulting in a significantly lower energy requirement for the entire system.

	Laminar Flow
Air outlet area	**9,5 m²**
Usable work area	**5,7 m²**
Discharge velocity	**0,45 m/s**
Air quantity	**15.390 m³/h**
Number of fans	**3**
Power consumption	
Filter unloaded	**6.600 W - 3x 2.200 W**
Filter loaded	**9.300 W - 3x 3.100 W**
Power requirement per m² usable area:	**1.160 W/m² to 1.630 W/m²**

	WIBObarrier Flow
Air outlet area	**9,1 m²**
Usable work area	**7,35 m²**
Discharge velocity	**0,35 m/s in the area ca. 1,1 m/s in the curtain**
Air quantity	**11.500 m³/h**
Number of fans	**3**
Power consumption	
Filter unloaded	**3.900 W - 3x 1.300 W**
Filter loaded	**7.800 W - 3x 2,600 W**
Power requirement per m² usable area:	**530 W/m² to 1.060 W/m²**

Conclusion:
WIBObarrier Flow is the energy-efficient solution for personnel protection concepts.

For applications where pure product protection is concerned, the power requirement for the two technologies WIBObarrier Flow and Laminar Flow is approximately equally high at 150-160 W/m² usable area. Therefore, criteria such as investment, concept preferences, and structural conditions dominate the technology decision. For applications where the product, operator, and environment must be effectively protected simultaneously, the power requirement of laminar flow systems is approximately 1,160-1,630 W/m² usable area. Here, WIBObarrier systems offer clear energy advantages at 530-1,060 W/m² usable area.

- **For pure product protection applications, laminar flow and barrier flow systems have nearly the same energy requirement.**
- **For product, personnel and environmental protection, a WIBObarrier system is considerably more economical in energy consumption. Barrier technology offers a larger usable area and more operator comfort through improved accessibility.**

Weiss Pharmatechnik is a competent provider of demanding cleanroom and containment solutions. The product program includes, among others, barrier systems, laminar flow systems, safety workbenches, isolators, lock systems and stability test systems. A comprehensive service network in the German-speaking region ensures smooth operation at all times. Weiss Pharmatechnik is a subsidiary of the Schunk Group with over 9,000 employees worldwide.

Weiss Pharmatechnik. Experience Safety.

---

weisstechnik

Weiss Pharmatechnik GmbH
Georg-Bölts-Straße 2-8
26135 Oldenburg
Deutschland/Germany

Kontakt
T. +49 (0) 441 57054-0
info.pharma@weiss-technik.com
weiss-pharmatechnik.com