Ventilation and exhaustion

Information sheet: Laboratory General RhL022

De tekst "Ventilatie en afzuiging" is ook beschikbaar in het Nederlands.

Information for employees and students working at the Faculty of Science (W&N)
This AMD information sheet discusses the several types of ventilation and exhaustion used in laboratories, and describes what type is best suited for which applications.

1 Ventilation device types

In laboratories polluted air may not be recycled. Devices equipped with a filter, that recycle air back into the room, are, therefore, not allowed, and are not discussed.

Ventilation ensures that the concentrations of hazardous substances and biological agents in the air remain low, so no flammable or explosive mixtures can form, or health damage can occur. There are several types of ventilation devices. In laboratories, for example, there are requirements set to room ventilation (See Chapter 2). In some cases a local exhaust ventilation provision (Chapter 3) may be sufficient, but more often you will want to use a fumehood for protection. Because the fumehood has such a prominent role in laboratory environments, and its effectiveness depends on its proper use, a separate AMD information sheet RhL023 "The fumehood" is available.
For certain types of equipment an enclosure and separate exhaust is preferred. For research in the Huygens complex the proper use of the off-gas installation is discussed.
To any ventilation system applies: these are sensitive systems. If there are any complaints, please do not start sealing off vents or adjusting valves, because you may cause problems elsewhere in the building. Please do ask the Facility Management/Building and Technical Services for advice.

2 Room ventilation

The aim of ventilation is to remove polluted air and bring in clean air. The capacity of the room ventilation is expressed in the air replacement capacity ("ventilatievoud"). The **air replacement capacity** is the number of times the air in a room is completely refreshed every hour, expressed in the unit h^{-1}. In practice this implies a high dilution factor. The air replacement capacity is calculated by dividing the ventilation flow rate in m^3/h by the volume of the room in m^3. Fumehoods that are permanently active, are part of the room ventilation.
The lower limit for the air replacement capacity in laboratories is 5 h^{-1}. For laboratories in which only analysis or measuring equipment is used, the limit may be lower, but one should take sufficient removal of any heat produced into account. In practice the air replacement capacity in chemical laboratories in the Faculty of Science lies closer to 10 h^{-1}. Building Services (Vastgoed) is responsible for the functioning of the room ventilation, because it is an integral part of the building.

When working with small amounts of not too hazardous substances (for example, aqueous solutions, buffers), working on the laboratory benches is allowed. When working with carcinogenic, mutagenic, teratogenic, or reprotoxic substances, corrosive substances, highly flammable/explosive substances, and nanomaterials, *or* working with large amounts of chemicals, one should always work in a fumehood, because room ventilation does not provide enough protection on its own.

Exhausting is a far less effective way to move air than blowing: Have you ever tried to extinguish a candle by suction?

3 Local exhaust ventilation provisions and enclosures

Local exhaust ventilation provisions ("hoods") are meant for places in which employees get near the pollution source, to prevent the inhalation of dust or vapour, or to vent off heat, for example, for the exhaustion of dust in workshops, or above a hot plate on a laboratory bench. Hoods often seem a good solution for exhaust problems, but are limited in their application. Ill-designed or badly applied, the effectiveness of a local exhaust ventilation is very small to zero!

Therefore, the exhausting of hazardous chemical vapours should be done in a fumehood, whenever possible. For equipment that does not fit in a fumehood due to its size, a properly designed local exhaust ventilation provision may be a solution, if the substance is released at one single location only. In such a case, said place may be covered. Often, this is a precision procedure. If the vapour is released at multiple locations, it is more effective to enclose and exhaust the entire set-up.

Whenever you do choose a hood, the type and location of the exhaust point need to be determined during design. Does it release a lot or a little vapour, and in which direction(s) does it spread? Is it going to be an exhaust wall, an exhaust bench, or a multi-position hood? If you need to exhaust a heavy vapour, do you choose an exhaust bench, so the exhaustion will be gravity-assisted, or do you choose a canopy ventilation hood, which, in such a case, will have to exhaust at a higher rate in comparison to one for lighter vapours, because those would rise by themselves.

The position of the local exhaust ventilation provision relative to the pollution source is crucial during use. In the ideal case, you would place the pollution source in the opening of the cover. This is because the capture velocity (the air speed necessary to actually entrap any pollution with the local exhaust ventilation) and the reach of the hood *diminish with the square of the distance*.
Therefore, every new user should be instructed to place the hood as close to the source as possible, that is, at a maximum distance of 10-15 cm (4 to 6 inch).

The application for and the installation of local exhaust ventilation provisions always proceed by using the Management-of-Change (MoC) procedure (see RhL070 *"Relocation and technical modifications"*) through the Building and Technical Services, who will ask AMD for advice, if necessary.

4 Microbiological safety cabinets and other exhaust cabinets

Exhaust cabinets are used mainly by biologists, pharmacologists, and physicists. These often serve to protect the product from dust or biological agents. However, there are types that also provide protection to the employee. These are often indicated with the phrase microbiological safety cabinets or biosafety cabinets. There are several types:

Class I: This laminar flow cabinet has a frontal opening and provides personal protection, but does not protect the product. The exhaust is provided with a HEPA filter.

Class II: Laminar downflow cabinet with a frontal opening providing personal and product protection. Suppletion air is sucked in from the room and serves to protect the employee; HEPA-filtered air flowing top-down keeps the product sterile.

Class III: These are entirely sealed; air is lead in and out through HEPA filters. Work is possible through a lock, and by putting your hands into the build-in gloves (glovebox).

Filters require regular replacement, and these cabinets must be registered in a maintenance contract.

These cabinets are sometimes referred to as laminar flow ("LAF") cabinets. However, for LAF cabinets a distinction is made between downflow cabinets, like the Class II microbiological safety cabinets, and cross-flow cabinets. Please be aware that, though in cross-flow cabinets the air is sucked in, even through a HEPA filter, the air is blown from the back wall of the cabinet into the employees face! Therefore, these do provide product protection, but no protection to the employee at all! Obviously, one is not allowed to work with hazardous substances in these cabinets.

The best known exhaust cabinet is the fumehood. There is so much to tell about these that we provide a separate AMD information sheet (RhL023) on the use of fumehoods.

5 Off-gas conduits and helium recycle conduits

We refer to those gasses/gas mixtures in harmless concentrations, that have been pumped with a (oil) rotary pump, as off-gasses. In the Kamerlingh Onnes Laboratory ("de meethal", measurement hall), and on floors 5 – 11 of the Huygens Laboratory, an off-gas conduit facility is provided for those. This device vents off-gasses by means of the underpressure in the off-gas conduit network. The connection points of several set-ups connect to one single exhaust conduit. Therefore, you need to know very well what you would like to vent off and whether that is allowed, to avoid an interaction of vented gasses from several set-ups!

Therefore, when you would like to start venting off-gasses, please start with a prior analysis of the flow rate and the chemical properties of the gas by performing a risk assessment of the set-up (see AMD information sheet *RhL010 Research risk assessment)*. By calculating the flow rate(s) it should become clear if the concentrations of toxic, corrosive, or flammable/explosive gasses are sufficiently low, or may be lowered sufficiently, to safely vent off the gas through the off-gas conduit. The risk assessment may also show that a separate off-gas conduit needs to be provided, because, for example, the material of the conduit needs to be of a certain quality, or that a certain exhaust flow rate must be achieved and gas monitoring is required. Or that adding nitrogen is required to remain far outside the explosion zone. Inert gasses, such as nitrogen and argon, can do no harm in the off-gas conduit, but are still suffocating gasses, so regarding this point the risk assessment should also show that the provided safety measures are sufficient! Please find more information about gasses in the AMD information sheet *VOM021 Working safely with gasses*.

Furthermore, the Huygens complex is provided with a helium recycle conduit to purify and recycle used helium. Please use this conduit; be aware that helium is a very rare and expensive gas. For any information we refer to the cryogenic department.