STEMBOT

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Filtering air

Key words

- Environmental sciences
- Pollution
- Masks
- Health

The science behind

Introduction

In this experiment, we built a homemade air filter to try and see which filtration system works best in face of pollution and debris.

Air quality and pollution

- Basic knowledge of air quality, air content, …

The **Air Quality Index** (AQI) is a number that defines the state of air quality in a given place at a given time, taking into account data from different **air pollutants** at the same time. This index serves to communicate the **status of air pollution** in their area or city to **citizens** simply and immediately so that they are aware of the air they are breathing and will breathe in the days to come. Each country has its air quality standards.

Air content is the amount of air contained in a concrete element, usually expressed as a percentage. **Air content testing** is typically required to check **air-thickened concrete** in areas where **frost damage** may occur.

Aerating admixtures added to the concrete mix create a uniform and stable air bubbles in the fresh concrete. These voids allow water to expand during the freezing phase without damaging the hardened concrete.

- Air pollution (toxicity, dirt, etc.)

Air pollution is the presence in the earth's atmosphere of physical agents (such as carbonaceous), chemical agents (such as hydrocarbons) and biological pollutants (such as anthrax) that **change the natural characteristics of the atmosphere**, harming living beings and the environment. These are usually agents that are not present in the standard composition of the air or are present but at a lower concentration level. Air pollution is caused by the diffusion of **excellent gases and dust** into the atmosphere. The primary sources of air pollution are **industrial activities**, **energy production plants**, **heating plants and traffic**, all of which are human activities. The areas most affected are large urban areas where industry, traffic and heating are concentrated. The phenomenon of smog is a consequence of air pollution in urban centres. It is a kind of acidic smoke, rich in dust and irritating gases, which settles like a fog in the lower layers of the atmosphere in winter.

Filtering concept

- Mechanism of filtration, process, and steps,….=

Air filtration systems become an unavoidable topic when we start talking about air pollution and air contaminants. These substances can essentially be categorized into three groups: particulate pollutants, biological pollutants, and pollutants from volatile organic compounds. Because all three of these types of pollution can and usually coexist, air filtration systems are designed and built to **handle each of these contaminants** most effectively, capturing them and releasing them into the air.

In infiltration systems, there is, first, a **first part** called **the pre-filter**. This component aims to collect all the large particulate matter (relatively speaking, we are referring to dust and dead skin cells, for example) in the the air, breaking it down into much smaller particles.

After the pre-filter comes the **high efficiency**, or **HEPA**, **filters.** The purpose of these devices is to capture particles much smaller than those described above. HEPA filtration systems are capable of trapping dust as small as 0.3 microns in diameter, and thus cigarette smoke, fungus and mould spores, bacteria, viruses, dust, pollen, and even the remains and droppings of dust mites. The presence of these contaminants, although entirely invisible, is constant in the atmosphere, and sound filtration systems can reduce their presence by up to three thousand times, with the predictable consequences on the healthiness of the air itself.

The **final part** of air filtration systems is **the carbon layer**. This component aims to **complete the purification of the air** by retaining contaminating organic compounds. In this final stage, the charcoal layer absorbs all these last contaminants, just like a sponge, releasing them into the air that can finally be recirculated and wholly purified.

- Types of materials

The **cell filter** can be used for the filtration of coarse dust and is, therefore, the first filter to be installed in the filter section of the UTA, also referred to as the pre-filter, or it can be used for the final filtration of fine dust.

Pocket filters are the most widely used type of filter because their structure allows a large amount of air to pass through concisely. This type of filter consists of a frame, which may be made of PVC or galvanised steel or aluminium, and filter pockets usually made of glass microfibre, which allows good separation of solid contaminants, such as pollen, from the circulating air.

The category of **absolute filters for Uta** includes HEPA filters (High-Efficiency Particulate Air Filter), i.e. air filters with very high efficiency and particulate filtering capacity in air handling systems of between 85% and 99.99%. They are mainly used in environments where there is the greatest need to make the air sterile, such as healthcare hospitals or industrial settings.

Active charcoal ambient air filters are used to reduce volatile organic, inorganic, and odorous substances. Activated carbon can be of vegetable origin (e.g., peat, lignite, coconut, or wood) or petroleum derivation. It has a granular and highly porous consistency, a characteristic that makes the material's surface exceptionally absorbent.

Electrostatic filters are an innovative and effective filtration system for trapping and separating solid and liquid particles from the air stream regardless of their size.

- Types of filtrations (interception, sedimentation, etc.)

Direct interception is based solely on size exclusion, and this filtration mechanism works equally well in air and liquids. Particles are removed from the filter media when they are larger than the pore size of the filter media or flow path. Filter pores more significant than the size of the contaminant allow contaminants to enter the filter media. Filter pores can be blocked by irregularly shaped particles or by two or more particles 'bridging' a filter pore, reducing the pore size and excluding smaller particles.

The inertial impact has a more significant effect in air filtration and occurs to some extent in liquid filtration. It happens when the airflow changes direction as it passes through the flow paths of the filter medium, and the contaminants leave the fluid flow lines due to their momentum, caused by their mass and velocity.

Diffusive interception is why it is easier for filters to remove contaminants from dry gases than from wet gases or liquids. It is why microscopic particles, smaller than the pore size of the filter medium or the flow path, are retained. It occurs because air molecules are always in a state of random motion.

In **electrostatic attraction**, charged contaminants (e.g., negatively charged bacteria and yeasts) are attracted to and retained by oppositely trusted filter media (e.g., positively charged filter media). The drier the air is, the stronger the electrostatic attraction force, while humidity reduces it. The higher the air velocity, the shorter the contact time between charged contaminants and charged filter media and the lower the efficiency of the filter and charged filter media.

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Every day life

Pollution in cities and everyday occurrence

- Practical examples

Despite an annual reduction in highly polluting cars and total emissions, **private urban road transport** remains one of the primary sources of pollution, partly due to incentives for dieselisation. And the most significant negative impact on air quality is in cities. Therefore, road transport is a major source of air pollutant emissions in urban areas (**road pollution**), and sustainable mobility would limit traffic pollution and air emissions from road transport.

Domestic heating is one of the first allies of air pollution despite today's focus on zero-emission technologies and renewable sources. Obstacles also come from environmental incentives and bonuses that do not focus solely on renewable energy plants but continue to push fossil fuel plants.

- Smog alert, pollution peak,…

A **smog alert** or **peak pollution** is a warning that is issued when there are **too many ozone particles**, fine dust or other pollutants in the air. This situation can be harmful to public health, so governments need to take measures. Smog is made up of different types of substances (ozone, sulphur dioxide, nitrogen dioxide and fine dust) that must not be present in too high concentrations in the air. When one or more values are exceeded, a smog alert occurs.

The European Union has set ozone alarm regulations. With an ozone value above 180 micrograms per cubic metre of air, the government must inform the population. At that value, sensitive people, young children, the elderly and asthma sufferers are advised not to make much effort outdoors.

The World Health Organisation assumes that at 120 micrograms, health risks may arise in certain groups. However, when the ozone value exceeds 240 micrograms, there is a danger to the entire population, and crisis plans come into force.

Types of masks and filters

- What types of masks for what usages?

The anti-smog mask is a **personal protective device** that can block fine dust and particles that pollute our cities' air. When present in high concentrations, these particles are responsible for various chronic diseases. However, even when it does not cause chronic pathologies, smog worsens the quality of the air you breathe and thus your quality of life. The main characteristic of an anti-smog mask is the **presence of a particulate filter layer**, which can trap PM 10 and PM 2.5 particles. However, not all masks have this type of filtering efficiency. The only models that manage to block fine dust are **FFP** and equivalent class models. However, not all masks in this class have the same level of filtering efficiency:

- FFP1 models manage to filter up to 72% of PM10 and PM 2.5
- FFP2 models block up to 95% of fine dust particles
- FFP3 models have a filtering efficiency that blocks 99% of suspended particles.

If a particular procedure must be followed to put on surgical or other masks, the same precautions are not necessary in the case of anti-smog masks. However, washing your hands before putting the mask on and before taking it off is a good idea in any case, for a few simple reasons:

If you have spent many hours outside the home, your hands have almost certainly come into contact with many dirty surfaces.

Touching the mask with dirty hands can encourage germs and bacteria to enter your respiratory tract. Apart from this common-sense rule, there is no need to follow other precautions.

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