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Usability of Activated Carbon Charcoal in Automotive Textiles for Car Deodorization: An Overview

M. Sasikala* and K. Sangeetha†

Abstract

With the swift progress in the automotive sector and the increase in time spent within vehicles, consumer expectations for cars have increasingly focused on enhanced comfort. Among the participants, 95% factored in in-car air quality when selecting a vehicle with about half of them considering it an important element in their purchasing decisions. Complaints about in-vehicle odors have long been a primary source of consumer dissatisfaction. Volatile organic compounds (VOCs) released from interior materials of vehicles play a major role in forming the overall odor profile. Being exposed to VOCs within vehicles can result in both immediate and long-term health issues, including headaches, eye irritation, dizziness, allergic reactions and respiratory concerns. Additionally, unpleasant odors may lead to both physiological and psychological challenges, such as stress and changes in mood. As such, the concerns surrounding in-car air quality and undesirable odors remain significant. While deodorizing a car is a technical task, using natural materials like activated carbon charcoal makes it relatively straightforward. Activated charcoal is created by heating charcoal in the presence of a gas, resulting in pores that enhance its ability to adsorb chemicals. Given their small size and low-volume pores, activated carbons are more effective at adsorption compared to absorption due to their increased surface area. It possesses various functional characteristics, including a desirable self-air filtering capacity. In addition to its antimicrobial properties, its ability to reduce odors underscores the importance of activated charcoal in both medical and industrial textiles. This paper highlights the characteristics of activated charcoal and its potential uses to eliminate odors from synthetic textile materials in automotive interiors.

* Department of Textiles and Apparel Design, Bharathiar University, Coimbatore, TamilNadu, India-641 046; hanuman2389@gmail.com

† Department of Textiles and Apparel Design, Bharathiar University, Coimbatore, TamilNadu, India-641 046; sangeethatad@buc.edu.in

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1. Introduction

1.1. Automotive textiles

Textile fibres are common in the sense that they are found in all modern buildings, cars and clothes. Everybody has their own textile environment, which includes their cars, clothes, upholstery and the objects and people they come into contact with. Depending on their design, purpose and other elements, textiles can shed or retain fibres [1].

Unlike textiles used in the fashion, creative or decorative industries, technical textiles offer technical, functional and performance features. Home textiles, packaging, sports, medical, protective, military, filtration, geo textiles, automotive, marine, aviation and other smart applications are among them. An overview of the main ideas around the problem of odour in automobile fabrics and activated carbon charcoal deodorization techniques is provided in this introduction. Additionally, it emphasizes how automotive textile sustainability and recyclability are becoming concerns across the board. The usage of non-biodegradable fibres is a primary factor contributing to the decreased recyclability of vehicle textiles. The development of biodegradable and sustainable technical automotive textile materials, which ought to be much easier to recycle and reuseis therefore a major area of research attention [2].

One lucrative industry that makes substantial use of technical textiles is automotive textiles. These fabrics are used for interior trims, safety equipment, including airbags and seatbelts, carpets, filters, battery separators, hood liners, hoses and belt reinforcement. Since the manufacture of cars is growing exponentially in almost all emerging countries, the automotive textile industry is thought to have one of the most promising growth prospects in the world. The majority of advancements in automotive parts, pieces and materials are driven mostly by considerations of economy, ecology, comfort, safety and functionality. The development process for automobiles is being altered by the use of 3D woven composites and now the textile industry is involved at every stage of the process rather than just one [3].

2. Review of Literature

2.1. Nature of odours

Many industries including apparel, automotive, food and beverage, fragrance, healthcare and environmental testingneed an odour sensor system [4].

Most smells are complicated blends. Nevertheless, little research has been done on the ability of olfactory sensory neurons (OSNs) in air-breathing vertebrates to comprehend complex olfactory information [5].

An odour is a combination of light and tiny molecules that are present in the air we breathe in very small amounts. The olfactory epithelium is a tiny area in both nasal cavities where odorants cause an electrical response of the olfactory nerves. Odour is also increasingly recognized as an environmental issue, with complaints stemming solely from one's own sense of smell. Additionally, odours have a significant impact on people's everyday lives and health because, while they pose no health risks to humans, they can induce physiological symptoms including headaches and psychological stress [6].

By using sensory terms and odor intensity scale one can describe the ambient smell in the car cabin, but also the odor from car parts or car raw and textile materials. It will be useful to the manufacturers in understanding the odorous characteristics of their car cabins assembly, according to the textile materials used. Despite the advancement of state-of-the-art chemical analysis, sensory analysis is still the preferred method for assessing perceived indoor air quality. This is a sensory instrument designed to assess the odour of car interiors composed of textile materials. Some of the standards serve as a common language in a sensory-descriptive analysis technique to characterize the nature of odour [7].

2.2. Odour factors in the automobile Sector- Usage of Synthetic Textiles

The interior of a vehicle is a specialized smaller-volume space that is filled with a wide range of materials, such as paints, lubricants, adhesives, soft and hard plastics, and many more. Large volumes of volatile species are released as a result, especially in the case of new cars and volatile organic compounds like benzene. We are not harmed by the typical 50 ml/sqft benzene concentration. It is possible for the temperature inside the car to be more than 20 °C higher than the outside air temperature. The amount of benzene in a closed car that is parked in the sun ranges from 2000 to 4000 ml/sqft, which is 40 times more.

Since many of these substances are poisonous and hazardous to human health, automakers and consumers have recently become more concerned [8].

The fragrance of a brand-new automobile is extremely particular. Buyers of vehicles are either drawn to or away from this distinctive smell, depending on the brand and class of the car. The primary focus of Original Equipment Manufacturers (OEMs) is the examination of hazardous substances and odorless primary components found in the gas phase of a vehicle's interior. Furthermore, OEMs typically lack the necessary tools to characterize odorants through instrumental analysis [9].

Inside a confined vehicle, volatile organic compounds (VOCs) emitted from automobiles degrade the air quality. Vehicle carpets are subjected to a wide variety of temperatures, which affect VOC and odour emissions and the occupants' physical and emotional well-being. Textile materials have several benefits, including comfort, ornamentation and noise reduction, and are widely used in both buildings and automobiles. They do, nevertheless, also contribute significantly to indoor settings as primary and secondary producers of VOCs. Some VOC emissions can be irritating or deemed nuisance odours, which can lower the perceived quality of indoor air. Because of their cramped interiors and inadequate ventilation, passenger cars are particularly vulnerable to the production and buildup of volatile organic compounds (VOCs) and have unique odour characteristics [10]. There are a lot of VOCs in the indoor air. The indoor environment contains several hundred chemical compounds (Brown et al., 1994; WHO, 1989a). Table 1 displays the primary classes.

Table 1: Classification of organic indoor pollutants

S. No.	Classification	Abbreviation	Boiling point range	Higher end of range	Vapor pressure^c kPa^d	Irritation thresholds^e μg/m^3	Odor thresholds^f μg/m^3
1	Very volatile organic compounds	VVOCs	<0	50-100	$>10^{-2}$	$1\text{-}10^6$	$0.1\text{-}10^6$
2	Volatile organic compounds	VOCs	50- 100	240-260 (a,b)			
3	Semi volatile organic compounds	SVOCs	240- 260	380-400	$10^{-2}\text{-}10^{-8}$		
4	Organic compounds	POM	> 380				

a) As stated by WHO (1989).
b) The higher end of the range is where polar VOCs are found.
c) Lewis, 1989.
d) 0.08 mm Hg-10-2 KPa.
e) According to the mouse bioassay, RD50 X0.03, mucous membrane irritation (Schaper, 1993).
f) Devas et al. (1990) stated thresholds for odour detection. [10]

Their ratios of indoor to outdoor concentrations further define them. According to Daisey et al. (1994), De Bortoli et al. (1986), Cohen et al. (1989), Lebret et al. (1986), Lewis (1991), and Wallace et al. (1991), the ratio is more than one for common indoor-related VOCs [11].

2.3. Properties of activated charcoal that reduce odour

Activated charcoal is an antidote that is recognized worldwide. Its many functional qualities include the highly sought-after self-air filtering capability in the automotive sector. Textile materials could include the same idea. Charcoal is the term for the partially burned or unburned carbon particles that are left behind after all volatile chemicals are released during combustion. The activation process will occur when the same remaining charcoal is heated to a high temperature. Charcoal activation causes changes to the internal structure of carbon atoms, such as a reduction in pore size or an increase in surface area. The larger pores in the activated charcoal will trap chemicals and poisons, preventing further absorption. Additionally, the negatively charged pores will draw in all positively charged molecules, including gases and toxins. These characteristics of activated charcoal make it suitable for application in textile fields or as a means of controlling odours in textile products. In addition, charcoal serves as a purifier and air filter. Characteristics of various conventional raw materials used for making activated carbon are given in Table 2 [12-14].

Table 2: Characteristics of various conventional raw materials used for making activated carbon [12-14]

S. No.	Raw materials	Carbon (%)	Volatile (%)	Density (Kg/M^3)	Ash (%)	Texture of activated Carbon	Application of activated Carbon
1	Softwood	40–46	55–60	0.4–0.5	0.3–1.1	Large pore volume	Aqueous phase adsorption
2	Hardwood	40–42	55–60	0.55–0.8	0.3–1.2	Large pore volume	Aqueous phase adsorption
3	Lignin	35–40	58–60	0.3–0.4	0	Large pore volume	Aqueous phase adsorption
4	Nut shells	40–45	55–60	1. 4	5–6	Large multi pore volume	Vapor phase adsorption
5	Lignite	55–70	25–40	1.0–1.35	5–6	Medium micro pore volume	Recycle
6	Soft coal	65–80	25–30	1.25–1.50	2.12	Medium micro pore volume	Gas-Vapor phase adsorption

In 2018, Thierry Le Blan and Arnaud Vatinel carried out research on the ability of automobile textile materials to reduce odours. Their research included a section on fabrics treated with activated carbon. They claimed that activated carbon was used as a functional material for textile fabric's anti-microbial and odour-control finishing. It was examined for active sites and applied using a coating process to the cloth surface. Chemical selectivity is dependent on (a) pore size, which includes mesopores (between 2 and 50 nm) and macropores (between 50 and 2000 nm). According to TSM Eza et al. (2013), activated carbon made from oil palm and coconut shells works well as an anti-odor agent on textile materials. They worked to prepare oil palm and coconut shells for use as activated charcoal. Subsequently, varying concentrations were applied to fabrics made of polyester and cotton. Their approach to applying activated charcoal to the fabric involved coating and pigment printing methods. They used two different methods to analyze odours: one involved testing human olfactory perception, and the other involved using portable electronic nose 3 (PEN 3) devices to assess how well samples were treated with the final anti-odour activated carbon. Their research led them to the conclusion that fabrics containing activated carbon can significantly lessen odour. They came to the conclusion from their investigation that coated activated carbon fabrics are superior to printed ones in comparison [12-14].

2.4. Principle of Activated Charcoal

Cars and other automotive vehicles emit air that is full of various toxic gases and chemical particles, which are readily absorbed by typical textile materials. Synthetic textile fabrics like polyester, nylon, and polyvinyl are the main source of odours and air pollution outside of the surrounding air. However, the use and presence of activated charcoal in automotive textiles will trap chemical particles and toxic gases in the pores found in the internal structure of the material, further impeding the process of absorption into any other medium. The cations, or positively charged ions, such as pollutants and chemicals in the air surrounding the automobiles, will be drawn to the anionic charge, or negatively charged ions, in the activated charcoal's pores and trapped there by the pores. Because the internal structure of activated charcoal has high pores count and size, it can retain a lot of those toxins and compounds from the inside [12-14].

2.5. Types of activated carbon charcoal

The physical and chemical characteristics of the finished product might vary greatly depending on the source material and the processing techniques used to create activated carbon. These results in a matrix of variations that can be found in hundreds of commercially made carbons. Despite this variance, activated carbon is primarily produced in three forms:

(1) Powdered Activated Carbon (PAC)
(2) Granular Activated Carbon (GAC)
(3) Extruded Activated Carbon (EAC) [15].

Figure 1 denotes the various forms of activated carbons.

			
4X8 Mesh	2X8 Mesh	Coarser Powder	Fine Powder

Figure 1: Various forms of Activated carbon

2.6. Structure of Activated Carbon charcoal

The basic chemical structures of AC and pure graphite are extremely similar. Weak van der Waals forces hold the layers of fused hexagons that make up the graphite crystal together. The gap between layers in the structure of AC is different from that of graphite. In graphite, the interlayer spacing is 0.33 nm, whereas in AC, it ranges from 0.34 to 0.35 nm. Based on their capacity to generate graphite, ACs is separated into graphitizing and non-graphitizing kinds. The graphitizing carbon contains many parallel-oriented graphene layers. The carbon produced is sensitive due to the weak cross-linking between the neighboring microcrystalline structures and the underdeveloped porous structure. The non-graphitizing carbons are robust due to the strong cross-linking between crystallites, and they have a well-developed micro porous structure. Non-graphitizing structures with strong cross connections can form more easily when linked oxygen is present or when there is not enough hydrogen in the original raw material [16].

The structure of thermally activated carbon is comparable to that of graphite 9, 10, as demonstrated by X-ray diffraction investigations given in Figure 2 [15].

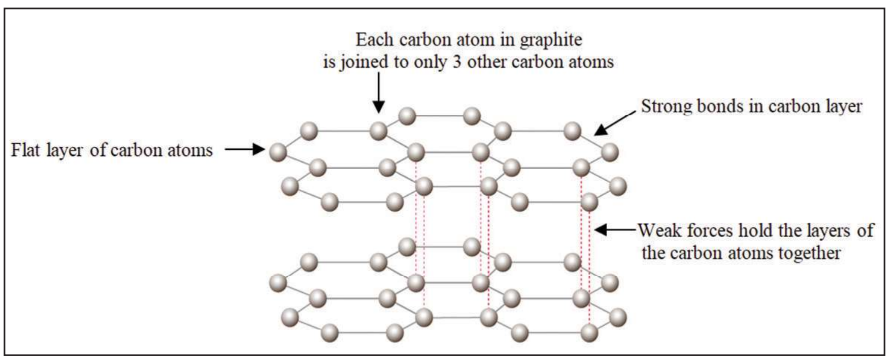

Figure 2: Structure of graphite [15]

Carbon atoms are bound together to form layers. The final characteristics of the AC, including its pore structure, are primarily determined by the raw material and production method. The question of what constitutes AC's structure has long been contentious. For the structure indicated in their book published in 2006, Harry Marsh and Francisco Rodriguez-Reinoso looked at over 15 models; nevertheless, they were unable to identify which was the most accurate. Recent work using aberration-corrected transmission electron microscopy has revealed that the structure of ACs is composed of heptagonal and pentagonal rings, which are fairly comparable to the fullerene structure. The porous structure and beneficial qualities of carbonaceous adsorbents are also influenced by the structure of the raw ingredients. Therefore, choosing the right material is just as important as deciding on the best production technology and determining the optimal processing parameters.

Consequently, research has been conducted to identify new raw materials that may be used to make carbonaceous adsorbents. In this regard, biomass waste from agriculture, wood, and other sources has garnered considerable attention [16].

2.7. Techniques for evaluating odours

In the realm of indoor air quality in the automotive sector, odour evaluation is a crucial subject. Limit values such as odour guidance values or odour activity values are derived from odour detection threshold (ODT) values. Major causes of variability have been discovered in stimulus preparation, which includes analytical verification, stimulus presentation, and test subject selection and training.

The idea of Odour Activity Values offers an additional method for assessing odours in indoor air. The concentration of a single drug divided by its odour threshold yields an odour activity value. According to Friedrich and Acree (1998), Hu et al. (2023), and Tsumura et al. (2023), it is possible to ascertain which components of a gaseous mixture contribute more to the overall odour and to create formulas for forecasting odour concentration or strength based on odour activity values [6].

The assessment of the chemical composition of odorous air serves as the foundation for instrumental methods used in odorant characterization. Prior to further investigation, the malodorous air must first be collected. Conventional VOC sampling techniques, such as absorbers, metal canisters and polymer bags are taken into consideration. The sampling protocols minimize losses and the chemical-physical interaction between odorants and the sampler medium, as well as guarantee sample integrity and maintain the original smell associated with the sample. In order to generate a list of the substances involved and their concentrations, gas chromatography coupled with mass spectrometry (GC/MS) has been widely used to analyze air quality. However, the main limitation of this technique is the complexity of the smell, as it is caused by numerous volatile chemicals that interact additively or synergistically under unpredictable rules, often at concentrations lower than the instrumental detection limit. Moreover, GC/MS equipment is costly and provides no insight into human perception, making it impossible to establish a direct relationship between a substance's quantification and olfactory stimulation. However, in an attempt to get beyond these restrictions, research has been conducted on the behavior of odorants in a mixture, possible masking phenomena, and the compatibility of instrumental and olfactometric techniques [17].

The mammalian olfactory system, whose tremendous complexity and effectiveness come from millions of years of evolutionary history, is without a doubt the most sensitive and wide-ranging scent detector. The limitations of conventional instrumental methods for measuring smells have drawn attention to odour measurement approaches that follow a scientific methodology and employ the human nose as a detector.

The primary method of odour assessment and quantification in the trade industry (food, beverages, perfumes, etc.) has long been the sensory evaluation of smells by panels of sensory-trained evaluators. This standardized method is known as dynamic olfactometric and is used to determine the concentration of odours and assess complaints about odours. The dilution factor required to attain the odour threshold- the lowest concentration that 50% of the population perceives- is quantitatively equal to the odour concentration, which is often represented in odour units (ou/ m^3). The amount of odorant that, when evaporated into 1 $m^3$of gas air at standard conditions, causes a physiological response from a panel (detection threshold) equivalent to that of n-butanol (reference gas) evaporated into 1 $m^3$of neutral gas is known as 1 ou/m^3, according to European standardization. Because the perception of smells is a logarithmic phenomenon, it is important to consider in these types of experiments that the relationship between odour strength and concentration is also logarithmic [17].

2.8. Sampling Methods for Odour Compounds

In order to minimize these interferences and prevent sample losses from sorption on the container, sampling is an essential step in the measurement process. The main critical points of the sampling procedure are the choice of sample container materials, the method for collecting odour, and the time allowed between sampling and analysis. Sample contamination can easily occur if inappropriate or unclean materials are used, and samples inevitably degrade or alter over time [18-19]

2.8.1. Materials

To reduce sample losses due to diffusion and/or adsorption, materials used for odour containers and sampling lines must be odorless, undergo no physical or chemical contact with the air sample, and have low permeability. Materials deemed suitable for smell sampling include glass, stainless steel, polyvinyl fluoride (Tedlar™), polytetrafluoroethylene (PTFE), tetrafluoroethylene hexafluoropropylene copolymer (Teflon ™), and polyterephtalic ester copolymer (Nalophan NATM). As a result, foul air is typically gathered in canisters-stainless steel containers, polymer bags, or on adsorbent materials [20-22].

2.8.2. Sampling Devices

Canisters are evacuated from previously cleaned cylinders that are good for air monitoring. Devices that are appropriate for volatile and polar compounds are passivated canisters [23].

Their use has two main benefits: no degradation of the trapping materials occurs, and the air sample is obtained without any breakthrough. To prevent contamination issues, canisters need to be properly conditioned and prepared, which calls for sophisticated sampling equipment. For dynamic olfactometry, canister sampling is ineffective; only polymer-based bags are appropriate. The collection of smelly substances is the main application for polymer bags. Specifically, sampling bags using materials like Nalophan^{TM} or Tedlar^{TM} are deemed suitable [24-25].

Since the pump and sample do not come into close contact, contamination is prevented with this procedure. To obtain results that are both representative and repeatable, the sampling technique must be modified to account for the various types of scent sources. In general, a dilution device must be used to reduce the risk of condensation while working with very concentrated gas samples, as well as in extremely hot and humid conditions. The reactivity of the various components in canisters or bags may impair the stability of the air sample and result in artifacts. In order to reduce sample losses, deterioration, or change, it is imperative that samples be examined as soon as feasible after sampling [26].

Because it allows one to sample a large volume of air while minimizing the number of analysts in a compact cartridge, sampling adsorbent materials packed in an appropriate tube is a more convenient sampling approach than using canisters and bags [24-25, 27-29]. Both "active" and "passive" modes of sampling can be used on adsorbent materials. A predetermined volume of sample air is pushed at a regulated flow rate during active sampling. Direct exposure to the atmosphere is used for passive or diffusive sampling; the process is controlled by the sorbent's adsorption characteristics and diffusion processes [30-32].

2.9. Sensory Methods

Sensory measures relate directly to the characteristics of odours as perceived by people by using the human nose as the scent detector. There are two types of sensory measurement techniques:

1. Quantitative measurements including the use of an instrument and the nose;
2. Parametric measurements with the use of the nose alone [33].

2.9.1. Instrumental Sensory Measurement-Dynamic Olfactometry

The human nose is used in instrumental sensory measurements in conjunction with an apparatus known as an olfactometer, which dilutes an odour sample with odour-free air in specific ratios to ascertain the concentration of the odour.

The following factors will influence olfactometric measurements:

- Olfactometer design;
- Test procedure;
- Differing sensitivity of observers;
- Data quality;
- Measurement uncertainty [33].

2.9.2. Design of the Olfactometer

The materials that are used to make olfactometer shouldn't contaminate or change samples via adsorption or desorption. Internal surface areas are kept to a minimum, and low-absorbency materials including glass, Teflon, Tedlar™ and stainless steel are utilized. Neutral air might be supplied in between each presentation to reduce the chance of contamination [33].

2.9.3. Test procedure of Olfactometer

When selecting which order to present the samples to the panel, it is crucial to keep in mind that a descending order may intensify the effects of adsorption and desorption and may also cause panelists to develop an olfactory adaptation as a result of being exposed to a strong odour at a lower dilution, which makes it harder for them to detect a weaker odour. However, this type of presentation can influence the panel reaction when dilutions take place in a tight order, as panelists anticipate that succeeding samples will be stronger or weaker. An ascending order display is recommended since, among these issues, the consequences of the descending order selection are more significant [33].

The panel can be presented with an odour sample using one of two conventional methods: the yes/no technique or forced choice [20-21, 34]. Two or more sniffing ports are utilized in the forced choice approach; at one port, the smell sample is supplied, and at the other port(s), neutral air is used. Examiners must evaluate the various presentations in this instance and determine the source of the odour emission. Using the yes/no approach, every examiner sniffs from a single port and reports whether or not an odour is noticed. Only neutral air or odour samples diluted with it can be released through the sniffing port. A set of chosen panelists are given samples of odour combinations at varying dilutions to smell, and their reactions are noted. To make the first mixture that is presented to an odour panel imperceptible to the human nose, it is often diluted with a huge volume of air. The volume of diluents is reduced by a present, consistent factor in future presentations. The logarithmic relationship between odour intensity and concentration can be described by constructing a geometric succession of dilutions after the factor has been determined [35].

The final result is computed as the geometric mean of the data collected for a particular series, as previously said, after various measurement cycles are completed [36]. The dilution needed to meet the panel detection threshold is used to express the concentration. The concentration can be stated mathematically as

$$C = \frac{V0 + Vf}{V0}$$

Where V0 is the volume of the odorous sample, C is the smell concentration, and Vf is the volume of odor-free air needed to cross the threshold. By comparison, the concentration for a dynamic olfactometer is provided by:

$$C = \frac{Q0 + Qf}{Q0}$$

Where Qf is the flow of odour-free air needed to cross the threshold and Q0 is the flow of the odorous sample. The concentrations might be given as dilution-to-threshold (D/T) ratios or as threshold odour numbers (TONNE). Despite being dimensionless, the concentrations are frequently thought of as physical concentrations and expressed as odour units per cubic metre (ou/m^3) [37-38].

2.9.4 Sensitivity of observers: panel selection

The trained examiners on the panel serve as sensors in olfactometric analysis, and the measurable parameter used to determine odour concentrations is their olfactory reaction, or odour threshold. However, as each person's olfactory sensitivity varies, panelists may report varying odour concentrations for the same sample. Because the examiners are chosen using a standardized process to pick people with average olfactory sensitivity-a representative sample of the human population-this effect is reduced [20-21, 34, 39].

- Average n-butanol odour threshold in the 20–80 ppb range (accepted n-butanol odour threshold: 40 ppb)
- Antilog standard deviation of individual responses of less than 2.3. Panelists need to adhere to a basic code of behavior and undergo ongoing screening and training [40-42].

2.10 Hybrid Instrumentation: Gas Chromatography-Olfactometry (GC-O)

It has been looked at whether there is a chance to use sensory perception in the development of traditional chemical analysis tools. The goal of the gas chromatography-olfactometry (GC-O) technique is to examine complicated mixtures of odorous substances by combining classic gas chromatographic analysis with sensory detection [43].

The GC-olfactometer is comprised of a standard GC where a split column splits the eluate between a standard detector (mass spectrometer (MS) or flame-ionization detector (FID)) and a sniffing port where an individual or panel with the appropriate training might identify the active species of odour. All olfactometric ports that are sold commercially fit the contour of the nose and are made of glass or PTFE cones. The eluate is transferred via a special tube that is heated to prevent semi-volatile chemicals from condensing. Auxiliary gas, or humid air, is given to the eluate to prevent the nasal mucosal membrane from drying, particularly in long-term analyses [44-45].

An olfactogram records the sensory reactions; eluate splitting makes this possible, enabling the analytical to reach both instrumental and human detectors at the same time so that the chromatogram and the olfactogram may be compared [44, 46].

Odour-active substances can be identified when a mass spectrometer and an olfactometric detector are combined, which is a particularly useful combination. Nevertheless, special attention must be paid to device assembly as well as the selection of carrier and auxiliary gas flows in order to prevent different retention times caused by the different working pressures of the two detectors [47]. Numerous techniques have been devised to assess the smell associated with every analytical that exits the chromatographic column in a qualitative and quantitative manner. Dilution analysis techniques, like Charm (Combined Hedonic Aroma Response Measurement) Analysis and AEDA (Aroma Extract Dilution Analysis), rely on a stepwise dilution of the sample, typically by a factor of two or three. The odorant FD value is the highest dilution factor (FD) that permits the perception of smells up to the point where no more odours are detected. Every odorant in the AEDA olfactogram is depicted by a bar, the height of which varies according to the odorant FD. The olfactogram peaks include the smell duration and the odour concentration because the charm analysis considers both the start and finish of each scent perception [44, 46, 48-51].

Instead of using one or two assessors, detection frequency methods employ a group of them. The number of evaluators who concurrently notice the odour at the sniffing port is used to determine the intensity of each compound's odour. In direct intensity measurement methods, various quantitative scales are used to measure the intensity of the eluting compound's odour. These scales can be single, time-averaged, registered after the analytic elution (posterior intensity evaluation method), or dynamic (OSME, finger span method) [44-45, 52].

In the environmental arena, the GC-O approach is increasingly being employed for evaluating food odours. This shifts the focus of odour emission assessment from olfactometric evaluation to the characterization of volatile components responsible for the odour nuisance. Animal production facilities' emissions of odours have frequently been the subject of GC-O approach investigations aimed at pinpointing the constituents causing the predominant smell impact and generating a thorough screening of volatile organic compounds (VOCs) released in the process using GC-MS analysis [44, 53-57].

3. Conclusion

An all-purpose anode that is safe and free of adverse effects is activated charcoal. Because of its adaptable functional qualities, its worth in the textile industry is doubled. There is no doubt that more research is required to improve the effectiveness of these charcoal products in the textile sector. Textile materials with activated charcoal finishes provide better air-filtering and anti-odor qualities, all of which have been demonstrated in practice. Improving air quality management necessitates the development of effective and efficient materials for the adsorptive removal of volatile organic and inorganic pollutants. This review offers insightful details regarding the use of activated carbon charcoal in odour-removing systems. Therefore, it will be highly noteworthy that activated charcoal is used in the automobile and textile industries in the future.

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Conflicts of interest

Concerning the publication of this research paper, I declare that there are no conflicts of interest. To the best of my knowledge and belief, the information presented in this paper is complete and accurate. As the corresponding author, I make this declaration on behalf of all authors who contributed.

Author contribution

All the authors have equally contributed in the work and in drafting the manuscript.

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