

Do Activated Carbon Scent Elimination Garments Really Work?

Answer: YES

Human Body Odour

Human body odour consists of a mixture of volatile and high boiling point components. The former are mainly amines and aldehydes (due to the breakdown of proteinaceous materials) and some sulphur compounds (depending on diet). The high boiling point compounds come from the bacterial action on fats and are typified by Butyric Acid. The groin area is mainly responsible for the volatiles whilst the acids tend to come from the armpits and upper torso.

Forces of Adsorption

Adsorption occurs in two distinctly different ways, chemisorption or physical adsorption, depending on the nature of the surface forces that attract and hold the odour molecules (adsorbate) to the substrate (in this case, activated carbon).

In physical adsorption, there is a van der Waals interaction (e.g. a dispersion or dipolar interaction) between the adsorbate and substrate. Van der Waals interactions have a long range but are weak, and the energy released when an odour molecule is physisorbed is of the same order of magnitude as the enthalpy of condensation. The enthalpy of physisorption can be measured by monitoring the rise in temperature of a sample of known heat capacity, and typical values are in the region of 20kJ mol^{-1} .

In chemisorption the particles stick to the surface by forming a chemical (usually covalent) bond. The enthalpy of chemisorption is very much greater than that for physical adsorption, and typical values are in the region of 200kJ mol^{-1} .

The differences in the general features of physical and chemisorption systems can be understood on the basis of this difference in the nature of surface forces.

Parameter	Physical adsorption	Chemisorption
Heat of adsorption (ΔH)	low, < 2 or 3 times latent heat of evaporation	high, < 2 or 3 times latent heat of evaporation
specificity	non-specific	highly specific
nature of adsorbed phase	monolayer or multilayer, no dissociation of adsorbed species	monolayer only may involve dissociation
temperature range	only significant at relatively low temperatures	possible over a wide range of temperature
forces of adsorption	no electron transfer, although polarisation of sorbate may occur	electron transfer leading to bond formation between sorbate and surface

reversibility

rapid, non-activated,
reversible

activated, may be slow
and irreversible

In summary, physical adsorption is a relatively low energy process, reversible, rapid and non-specific in the molecules it can capture.

Chemisorption is a more energetic process creating chemical bonds; is highly specific in its target molecules and typically not reversible as the odour molecule is often chemically altered by chemisorption.

Adsorption onto Activated Carbon Scent Elimination Garments

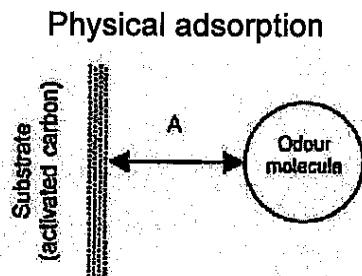
In this application adsorption takes place in the gas phase; this is a condensation process where the adsorption forces condense the molecules from the bulk phase within the pores of the activated carbon. The driving force for adsorption is the ratio of the partial pressure and the vapour pressure of the compound. This ratio is altered when heat is applied e.g. in the tumble drier.

To achieve chemisorption the activated carbon needs to be tailored to the specific process.

Generally activated carbons used in scent elimination garments are untailed. The activated carbon is therefore not very selective, the pores and its specific surface area are the only restraints on the molecules which can be adsorbed. The adsorption capacity of activated carbon can exceed 60% of its own weight for some organic compounds.

The forces occurring in this case are largely those of physical adsorption and if enough energy is applied to overcome the physical forces of attraction (van der Waals interaction) the process is reversible.

When a saturated scent elimination garment is placed in a tumble drier the odour molecules that have low physical forces of attraction are desorbed.



A: reversible van der Waals forces

In conclusion if the molecule has been chemically adsorbed onto the substrate desorption can only occur with activation (very high temperature – equivalent to

those initially required to activate the carbon, circa. 1000°C) and is in certain circumstances completely irreversible.

Physically adsorbed molecules however, can be readily desorbed and require no activation e.g. desorption of odour molecules will occur on tumble-drying.