



Chemistry and Industry for Teachers in European Schools

CHEMISTRY CHANGES EVERYTHING

Deodorants and Antiperspirants

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Education and Culture

Socrates
Comenius

CITIES (*Chemistry and Industry for Teachers in European Schools*) is a COMENIUS project that produces educational materials to help teachers to make their chemistry lessons more appealing by seeing the subject in the context of the chemical industry and their daily lives.

The CITIES project is partnered by the following institutions:

- Goethe-Universität Frankfurt, Germany, <http://www.chemiedidaktik.uni-frankfurt.de>
- Czech Chemical Society, Prague, Czech Republic, <http://www.csch.cz/>
- Jagiellonian University, Kraków, Poland, http://www.chemia.uj.edu.pl/index_en.html
- Hochschule Fresenius, Idstein, Germany, <http://www.fh-fresenius.de>
- European Chemical Employers Group (ECEG), Brussels, Belgium, <http://www.eceg.org>
- Royal Society of Chemistry, London, United Kingdom, <http://www.rsc.org/>
- European Mine, Chemical and Energy Workers' Federation (EMCEF), Brussels, Belgium, <http://www.emcef.org>
- Nottingham Trent University, Nottingham, United Kingdom, <http://www.ntu.ac.uk>
- Gesellschaft Deutscher Chemiker GDCh, Frankfurt/Main, Germany, <http://www.gdch.de>
- Institut Químic de Sarrià, Universitat Ramon Llull, Barcelona, Spain, <http://www.iqs.url.edu>

Other institutions associated to the CITIES project are:

- Newcastle-under-Lyme School, Staffordshire, United Kingdom
- Masaryk Secondary School of Chemistry, Prague, Czech Republic
- Astyle linguistic competence, Vienna, Austria



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DEODORANTS/ANTIPERSPIRANTS



(google images)

Introduction

The cosmetics industry produces billions of items worldwide every year. Quite a large proportion of these include deodorants and antiperspirants.

'Body odour' is never a pleasant topic of conversation. Men, women and children from all walks of life use deodorants to cover up this natural emanation. Antiperspirants are also used to try to prevent the formation of sweat (the more usual term for perspiration), which is responsible for the unpleasant smells we associate with perspiration.

When did this all begin?

Certainly by the time of the ancient Egyptian civilization, people were conscious of their bodily odours and took baths regularly. Aromatic oils were applied to the body in order to create appealing aromas. Ancient Romans followed a similar procedure.

The whole idea of bodily cleanliness and freedom from smell took a significant downturn following the fall of these empires and people started to take personal hygiene far less seriously, with predictable consequences!

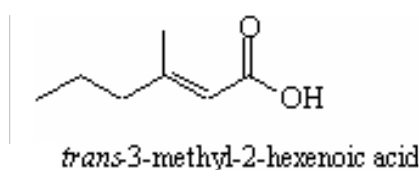
In Victorian times (and even earlier) ladies would carry small bags of flowers or herbs in order to mask their body odour.

It was not until 1888 that a commercially-available deodorant came onto the market with the production of "MUM" in the USA. Since then, the industry has expanded to the current stage where there are thousands of products available worldwide, in a variety of forms.

So what's the difference between deodorants and antiperspirants?

Deodorants

These are substances which are applied to the body in order to cover the natural odours produced by the bacterial breakdown of proteins present in perspiration. They frequently contain pleasant-smelling fragrances which are much more appealing to the olfactory senses. The principal product of this bacterial breakdown is E 3-methyl-2-hexenoic acid (sometimes called *trans* 3-methyl-2-hexenoic acid):



(E 3-methyl-2-hexenoic acid)

which is responsible for the unpleasant smell we associate with body odour. The other geometric isomer, Z (or *cis*) 3-methyl-2-hexenoic acid also contributes to the odour, but to a lesser extent.

Antiperspirants

These are substances which considerably reduce the amount of perspiration released by the sweat glands. As a result of this, less bacterial breakdown occurs, resulting in a decrease in the amount of odour produced. Many deodorants also contain an antiperspirant, but the reverse is not automatically true.

Is this really chemistry?



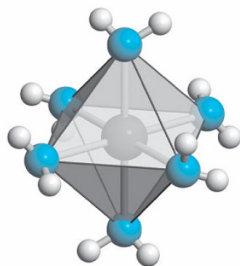
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WHAT'S THE CONNECTION?



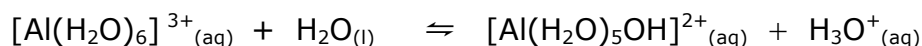
(alcan)

Most antiperspirants include aluminium chlorohydrate as the active ingredient. This has the chemical formula $\text{Al}_2(\text{OH})_5\text{Cl}$. Perspiration contains several substances, including water. When aluminium chlorohydrate comes into contact with water, a hydrolysis reaction occurs which results in the formation of the hydrated aluminium ion $\text{Al}^{3+}_{(\text{aq})}$. This is more correctly written as the complex ion $[\text{Al}(\text{H}_2\text{O})_6]^{3+}_{(\text{aq})}$:



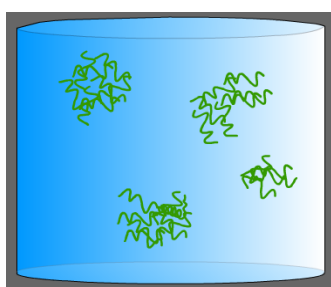
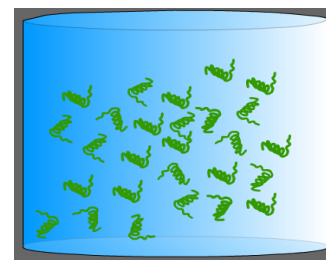
This is described as being an octahedral complex, with six water molecules loosely bonded to the central aluminium (Al^{3+}) ion. These bonds are called dative covalent bonds, in which both of the two shared electrons are provided by the oxygen atom of each water molecule. The oxygen atoms are classed as donor atoms.

In the presence of the water in which it is dissolved, this complex undergoes an acid/base equilibrium reaction with the water:



As can be seen, H_3O^+ ions are formed. These are the ions responsible for acidity. The formation of these ions has two important effects:

1. The pH of the treated area falls below 7, which is not the optimum condition for bacterial action (bacteria prefer alkaline conditions)
2. Sweat contains proteins, which under normal conditions are water-soluble. The presence of the H_3O^+ ions causes the structure of the proteins to change. The proteins are said to have been 'denatured'.



When denaturing occurs, the proteins fold themselves differently, causing them to lose their solubility. As a consequence, the proteins are precipitated out as a gel which plugs the sweat glands, preventing these glands from releasing any more perspiration.

This characteristic of aluminium is called 'astringency'.

So, do you want to try something out?

Here's a very simple test you can easily perform. Take a can of antiperspirant and spray it onto a strip of universal indicator paper (it is necessary to put a few drops of water on the indicator paper first.) You should see a red/orange colour, indicating an acidic reaction, with a pH in the region of 3. This should also work if the antiperspirant is in stick form.

Clearly, the antiperspirant is acidic, as explained earlier.

You could try the effect of making a dilute solution of citric acid in water and applying this to **one** of your underarm areas (**NOTE:** do not do this if there is any evidence of irritated or broken skin.) You should now undertake some physical activity which is likely to make you perspire, for example running. Some time later (*before* showering!) comparison of your two underarm areas should show a lesser amount of odour on the area previously treated with the citric acid, thus confirming that an acidic environment is likely to suppress the fermentation process which results in the formation of body odour.

(Cider vinegar or white wine vinegar could also be used instead of the citric acid solution with a similar effect.)

How are they made?



Both antiperspirants and deodorants consist of the same fundamental ingredients.

These are:

- emulsion of either water/oil or water/silicone
- emulsifiers (to prevent the immiscible components from separating)
- thickening agents
- waxes
- biocides and/or aluminium salts (such as aluminium chlorohydrate)
- colouring agents and fragrances
- preservatives (to extend shelf-life and to prevent reactions between the ingredients)
- propellant gases (for aerosols only)

Since these items are available as aerosols, sticks, roll-on liquids and gels, the specific manufacturing processes will vary, but the same basic principles apply to all.

- Solvents (frequently ethanol, or other alcohols) are initially added to the mixing vessel. Silicones, such as dimethicone may be used as an alternative. This is called the *CONTINUOUS PHASE*.
- Solid ingredients e.g. cetyl alcohol are added to the *OIL PHASE*.
- A third "*DISPERSED PHASE*" is also prepared, which is essentially water-based (although, if a stick type is being produced, oil would be used instead of water.)
- The active ingredient – either biocide or aluminium chlorohydrate, is added to this dispersed phase along with gelling agents. All three phases are then blended together to form an emulsion.
- Colouring material and fragrances are added next and blended in.
- The final product is put into containers

What are the benefits/risks?

The benefits are obvious. No-one likes to be seen with perspiration marks on their clothing; some people prefer to have evidence of antiperspirants visible, rather than have perspiration marks. Similarly, there is a great social stigma associated with body odour; this can lead to unpleasant exchanges or even ostracism. Individuals are often criticized for having poor personal hygiene standards. Anything which can help to minimize this will be of immense benefit to the individuals concerned.

The cosmetics industry relies on people having personal hygiene as a very high priority, which results in it having a multi-billion euro turnover annually.

On the other side of the coin, there are many serious questions as to the potentially harmful effect the use of antiperspirants has on the health of its users. There have been many studies into the possibility of breast cancer being linked to antiperspirant use, particularly **aluminium**-based antiperspirants. Most researchers have failed to find a definite link.

Aluminium has been classified as a neurotoxin. It has been shown to have a detrimental effect on the blood-brain barrier and has been associated with epilepsy and Alzheimer's disease. Studies are still on-going, but as yet, no causal link has been confirmed.

There is also concern that users who have renal dysfunction may be jeopardizing their health by the use of **aluminium**-based antiperspirants.

Future developments?

The increase use of products which do not rely on **aluminium**-based additives
New methods of application?
Research into increased use of natural antiperspirants/ deodorants
Deodorant pills are being developed currently

Intrigued by what you have read?

There is a wealth of material available to consult. Here are a few you might consider:

<http://www.controlyourimpact.com/articles/deodorants-antiperspirants-and-your-health/>

www.silverson.com

<http://search.unilever.com/search/deodorant>

<http://en.wikipedia.org/wiki/Deodorant>

<http://health.howstuffworks.com/question627.htm>

http://health.howstuffworks.com/framed.htm?parent=question627.htm&url=http://www.fda.gov/fdac/features/2005/405_sweat.html

<http://www.care2.com/greenliving/deodorant-or-antiperspirants.html>

<http://en.wikipedia.org/wiki/Antitranspirant>

A final note

The production of perspiration is a fact of life which we all must learn to live with. We each find ways to deal with it, often as outlined in the foregoing article. Once mastered, body odour is a relatively minor inconvenience.

Unfortunately, a small percentage of the population suffers from a medical condition which causes them to over-produce perspiration. This needs medical treatment, as the use of antiperspirants has little or no effect. Similarly, there are those individuals who will always have unpleasant body odour, irrespective of the steps they take to combat it. Once again, medical treatment is necessary in these cases.