Dr Nathalie Nibbe, Dr Hansruedi Gygax – Odournet, Germany

Odour analysis in personal care products

The human sense of smell has been underestimated for a long time. However, recent research shows that it is closely connected to emotions, memories, approach and avoidance, and also evaluative judgment. Therefore, the scent of a product can have a significant impact on consumers' product experience, its liking, the evaluative judgment of the products' qualities, and the products' purchase intention. Because of this, more and more companies are focusing on reducing, neutralising or masking unpleasant scents from their products or developing products with reducing or neutralising functions.

In order to measure odour performance (odour reduction, longevity of fragrances, etc.), reliable and repeatable olfactory measurements should be carried out. The results can help R&D to optimise the product, support quality control and can also be used by marketing for example as claim support. The following article summarises the key elements and possibilities of odour measurements.

Odour measurement

Odour measurement separates into two major fields:

- Sampling.
- Analysis.

Sampling is highly dependent on the product segment, the product itself, and the objective of the study. For certain product segments, standards have been developed (e.g. deodorant testing according to ASTM-E-1207-09) but for all products it is advisable to develop and perform individualised sampling strategies which are tailor-made to the product or material to be tested, to achieve conditions that are as 'real' as possible. This is the basis for the best possible analysis results.

Odour analysis can be subdivided into:

- Human sensory olfactory analysis.
- Molecular anaylsis.

Human olfactory analysis

As of now, there is no analytical tool that can replace the human nose completely. Even the most sensitive and most recent

instruments sometimes cannot detect odour molecules while the human nose can detect a clear odour signal.

The most common parameters are odour concentration, odour intensity and hedonic tone.

The odour concentration can be determined by measuring the odour threshold concentration which is defined as the concentration at which an odour molecule can be detected with a probability of 50%.

For mixtures of odour molecules it is possible to measure the odour concentration by the method of dynamic dilution olfactometry, which is used worldwide. An olfactometer comprises a sophisticated system which dilutes odour samples with neutral air and presents them to a test panel for assessment. Since standardisation is the key for reliable results in human sensory olfactory analysis, the guidelines and norms of EN 13725 are to be applied and the odour concentration is measured in so-called Odour Units.

This parameter is useful to describe the odour impact of products. It can be used to measure the odour reduction of malodours or longevity of fragrances. However, odour concentration does not correlate directly with the odour perception. For such measurements other sensory methodologies have been developed.

To assess the odour perception in a repeatable way, the most common parameters measured are intensity and hedonic tone.

In daily life, people routinely and quickly distinguish if they like an odour or not, which can lead to approach or avoidance behaviour. Consumer research even suggests that odour perception primarily occurs in terms of its pleasantness or unpleasantness, the individually- and positively-evaluated stimulation of the olfactory sense.

Beyond pleasantness, individuals perceive and respond to a scent's intensity. The relationship between pleasantness and intensity is complex and can often be characterised by an inverted U-shaped function. A perfume smells good, perhaps even better as the intensity increases, but only up to a certain point. Beyond that point the scent becomes so intense that it becomes unpleasant. Yet, with some scents, the relationship between intensity and pleasantness may be linear rather than bell-shaped: Whereas a light fish odour may be acceptable, the evaluation may become continually more unpleasant as the intensity increases.

It is a challenging task to determine these on an absolute scale since intensity and hedonic tone cannot be judged independently. Therefore the standardisation of such measurements is very important. The VDI 3882 allows the rating of intensity on a 7-point scale by answering the question 'How strong is the odour?', while the measurement of hedonic tone, which can be performed at the same time, answers the question of 'How pleasant is the odour?'. Depending on the information required, this can be done with trained expert panels or with representative panels.

Besides intensity and hedonic tone, it is also possible to record odour acceptance or to focus on the odour character. One of the most demanding tasks is to establish a sensory description of the odour character. It requires extensive training of expert panels prior to do a sensory odour description. Naïve panellists, however, can do a so-called polarity profile, with which they assess an odour character by rating contrasting pairs of odour attributes (e.g. fresh/mouldy, etc.).

As a very important aspect of sensory

odour measurements, it is necessary to highlight the need for consistent smelling. Even evaluation from the smelling strip has to be learned and trained. To facilitate consistent smelling, Odournet GmbH has developed the PureSniff device. This is an instrument which presents the headspace over a sample in undiluted form when a panelist activates a switch. It is a universal tool for preparing and presenting the headspace and thus presents the scent of a product in its pure form.

The assessing of scents by panellists is very fast, and allows the capturing of sensory related information based on the human perception. Nevertheless the measurement of molecular based information is mandatory for revealing important facts, which determine – among others – the scent performance over time.

High-end molecular spectroscopy can be linked to human perception

Over recent decades, molecular spectroscopy methods to analyse headspace compositions have evolved tremendously. Today's GC-MS/TOF instruments can detect molecular traces at concentration levels hundreds of times lower than standard GC-MS Instrument. Scents, especially when they contain natural ingredients, reveal a high complexity. The combination with the human nose as complementary detector, allows recording of the GC-Olfactometry trace (GC-Olfactogram). Linking the molecular information from GC-MS/TOF with the perceived intensity and perceived odour quality allows detailed understanding of the key odour impact molecules present in the scent. With this analysis, it is also possible to identify molecules responsible for scent distortion.

Very recently an interesting combination of analytical technology became available. While IMS has been used successfully for fast detection of airborne molecules, its main application was to detect traces of plastic explosives at airports, to find traces of drugs, or for military applications such as the detection of warfare agents. The combination with GC-separation opens up a new technique to visualise the presence of scents in a 2D fingerprint. The headspace of a product is collected and injected in a short GC-multicapillary column. When eluting from the column, the molecules are ionised, and analysed in an Ion Mobility Drift-tube. Within a short sample processing time (a few minutes), the 2D fingerprint is recorded and can be analysed and compared in various ways. Presence or absences of key components of a scent are seen immediately and sophisticated data processing methods allow the quantification and identification of the molecules of interest and the visualisation of molecular headspace over time.

GC-IMS in particular can be used to observe the 2D fingerprint over time to study the dynamic changes of a cosmetic product or perfume after its application onto skin, or to compare the similarity/ difference of products. And last but not least, it is possible to visualise the formation of off-notes during the product's shelf life.

Conclusion

Overall, odour measurements can help to answer a variety of questions about odour reduction, longevity of fragrances, or molecular odour structure in personal care products. The essential part in all objectives is the compliance of standardised procedures for repeatable, reliable results. PC