CHEMICAL ENGINEERING TRANSACTIONS
VOL. 30, 2012
Guest Editor: Renato Del Rosso

ISBN 978-88-95608-21-1; **ISSN** 1974-9791
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at: www.aidic.it/cet
DOI: 10.3303/CET1230057

Evaluation of Odour Release from Urine Absorbing Aids

Selena Sironi*, Laura Capelli, Licinia Dentoni, Renato Del Rosso

Politecnico di Milano, Department of Chemistry, Materials and Chemical Engineering "Giulio Natta", Piazza Leonardo da Vinci 32, 20133 Milano
selena.sironi@polimi.it

This paper describes the method to assess the urine malodor reduction measured on absorbent articles designed to handle unintentional urine loss of different severity, ranging from few drops to complete loss of bladder control. The method allows the comparison and ranking of the absorbent article performances and efficacy against the urine malodor.

1. Introduction

As the adult ages, the risk of urinary incontinence increases with significant impact on the physical and emotional health of the patient. Risk factors include advancing age, female gender and it is thus an important clinical and social problem in the elderly today, expected to grow further. There are varying reports of the female population suffering from incontinence. In a survey conducted on 2400 people (Roberts et al., 1999) the authors report a prevalence of urinary incontinence of 48.4 %.

Absorbent articles are being developed to help not only managing urine loss, but also decreasing the social impact. Many types of urine absorbent products are available on the market. They can have different shape, material, technology or design. The International Standard (ISO 15621, 2011) reports how to evaluate and compare different urine absorbing products. This International Standard supplies general guidelines on evaluation of urine-absorbing aids, lists the five most important factors for users and caregivers of absorbent incontinent products, gives guidance for how these factors can be evaluated and, finally gives an overview of testing methodologies and interpretation of test results.

Freedom from odor is one of the most important factors as the perception of urine malodor from the worn absorbent product by users or others have a significant impact on self esteem and social interaction and might represent an additional psychological burden to the incontinence itself.

A possible way of evaluating freedom from odour leakage is to use sensory analysis methods (ISO 6658, 2005). According to this International Standard, different types of sensorial tests, performed by chosen and trained assessors, can be used to estimate the order or size of differences, or categories or classes to which samples should be allocated.

This work shows an approach to value the odour released from different urine absorbing products by the use of objective sensorial evaluation executed by expert sniffers described by specific European Norm EN 13725 (CEN, 2003).

The aim of the study is to investigate the possibility of comparing the performance of different absorbent aids in terms of odour control by discussing a suitable methodology for the product evaluation.

The data presented in the study are averaged from a set of analyses run on a conspicuous number of products, which can be grouped into two different classes: absorbent aids with or without odour control system, respectively.

Please cite this article as: Sironi S., Capelli L., Dentoni L. and Del Rosso R., 2012, Evaluation of odour release from urine absorbing aids, Chemical Engineering Transactions, 30, 337-342 DOI: 10.3303/CET1230057

The proposed methodology may effectively be applied for the comparison of single commercial products both for pair or multiple evaluations.

2. Materials and Methods

2.1 Identification of synthetic urine

Identification of artificial urine is necessary to perform repeatable tests and to supply the sensorial assessors with fluid with no biological contamination.

Artificial urine is prepared based on bibliographic studies (Tyan et al., 2007; Mills et al. 2001; Perring et al., 2007), and dosing volatile compounds in a mixture of water and salts. To simulate microbiological activity that occurs in the biological fluid, a well known quantity of enzyme is dosed in the mixture.

Sensorial measures are carried out to optimize synthetic fluid in terms of ratio among volatile compounds, with the aim to obtain artificial urine similar for odour concentration and hedonic tone to biological urine.

2.2 Analysis methodology

The International Standard ISO 6658 constitutes a general introduction to the methodology of sensory analysis. Sensorial evaluation are of different types and are normally classified by Standards as concentration measurements (CEN, 2003), intensity measurements (VDI 3882- part 1, 1992) correlated to the concentration measurements with different relations as Weber Fechner law or Steven law (Zhang et al., 2002) and to hedonic tone measurements (VDI 3882- part 2, 1994). The assessment of absorbent articles performance to control urine malodor includes both the concentration and the hedonic tone of the odor released by the article itself loaded with synthetic urine.

2.2.1. Measure of odour concentration

Dynamic olfactometry allows to determine the odour concentration (c_{od}) of an odorous air sample, which is expressed in European odour units per cubic metre ($ou_E\ m^{-3}$), and represents the number of dilutions with neutral air that are necessary to bring the odorous sample to its odour detection threshold concentration (CEN, 2003). The reported value of odor concentration is the average of 12 values of odour threshold concentration.

2.2.2. Measure of hedonic tone

The hedonic tone (T.E.) describes the pleasantness/unpleasantness associated to the gaseous samples as measured by at least 15 selected people (panel) on a 8 points scale. The choice of people selected to perform sensorial analysis and the method of measurement for the hedonic tone evaluation are detailed in the German Standard (VDI 3882- part 2, 1994). Starting from the odour detection threshold concentration, six dilution steps are prepared. The panel measures the hedonic tone of the samples for every single dilution steps and ranks them on a scale where -4 value is an extremely unpleasant odor and + 4 an extremely pleasant odor. The reported values are the average of the hedonic tones of each of 6 dilution steps of specific sample up to the detection threshold, expressed by the 15 expert graders (panel). Thus, each reported value is the average of 90 assessments.

2.3 Comparison tests between biological and synthetic urine

Sensorial measurements of odour concentration and hedonic tone have been performed on real biological urine and synthetic urine. Real biological urine was sampled among 20 healthy individuals, 50 - 90 y old, within 24 h long urine collection. This procedure allowed a reasonable representation of inter and intra individuals variability of urine composition.

200 mL of fluid have been stored for 2 h into 6 L Nalophan bags filled with air. The headspace air in contact with the fluid has been then analysed.

2.4 Comparison tests between urine absorbing products

The absorbent articles are prepared flat on the bench and loaded with an amount of synthetic urine that is representative of the average loading of urine that can be present in urine absorbent products of a specified size. For instance, for products used for the Light Incontinence, usual loading is below 30 mL of urine, for products specific for the Severe Incontinence, it is common that the users load each product around 300 mL. The chosen amount of synthetic urine is loaded in the center of each product sample. Each sample is then positioned into a Nalophan bag and in contact with 6 L of neutral air. The bags are stored at 37 °C body temperature for time representing average use time of the products by the users (range 4 – 8 h), during which the headspace is filled with volatile compounds coming from the products loaded with the synthetic urine. The bags are wrapped into additional black bags and proceed to the olfactometric analysis (CEN, 2003; VDI 3882-part 2, 1994)

3. Results and discussion

3.1 Olfactometric tests on biological and synthetic urine

The results of the olfactometric assessment show a very good correlation of our synthetic urine with the real biological urine both in terms of qualitative assessment (hedonic tone) and quantitative measurements (odour concentration). The synthetic urine is in line with the real biological urine (sampled from individuals of different age and during the day) when it is aged 24 h representing the worst case scenario of an absorbent pad from its wearing to its dispose. Importantly, the synthetic urine show odor stability during the 24 h time, reinforcing the reproducibility of the test. Figure 1 shows the odour concentration trend of biological and synthetic urine. Odour concentration values reported in Figure 1 are the geometrical mean of 12 odour threshold values (in accordance with EN 13725).

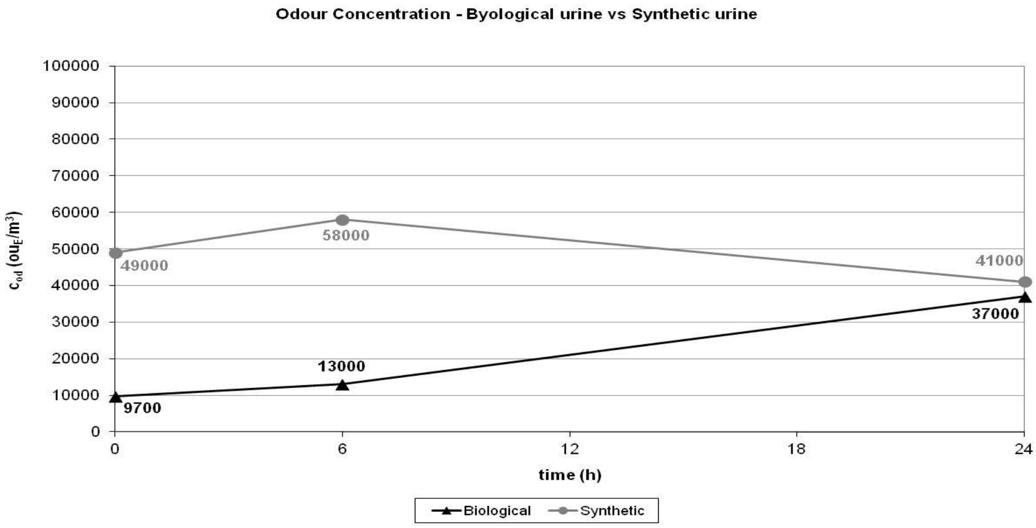

Figure 1: Biological and synthetic urine: odour concentration trend

Figure 2 shows the hedonic tone trend of biological and synthetic urine. Hedonic tone values reported in Figure 2 are the arithmetical mean of 90 hedonic tone values from 15 panellists at 6 dilution steps.

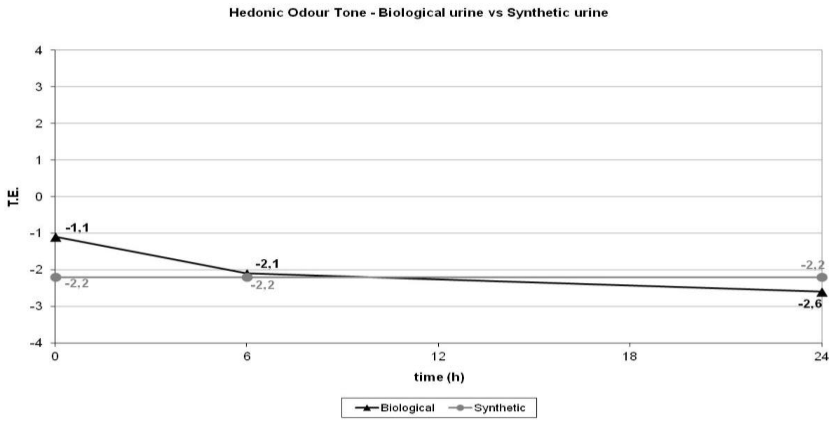

Figure 3: Biological and synthetic urine: hedonic odour tone trend

The results obtained show synthetic and biological urine to have very similar hedonic odour tones, except for the test run shortly after sample preparation (15 min). As previously discussed for the odour concentration, for the purpose of olfactometric evaluations on urine absorbing aids, it is important for the synthetic urine to be representative of the biological urine aged 24 h, which is the time interval for the pad final disposal.

3.2 Olfactometric tests on urine absorbing aids

3.2.1. Odor concentration measurements

Odour concentration analysis have been performed on marketed products with or without claimed odour control. When measured odour on both these type of products, despite differences in the type of odor, no significant differences in odor concentration have been measured. Figure 3 shows the odour concentration trend (c_{od}) of synthetic urine on different absorbing products with or without odour control technology. Odour concentration values are the geometrical mean of 12 odour threshold values.

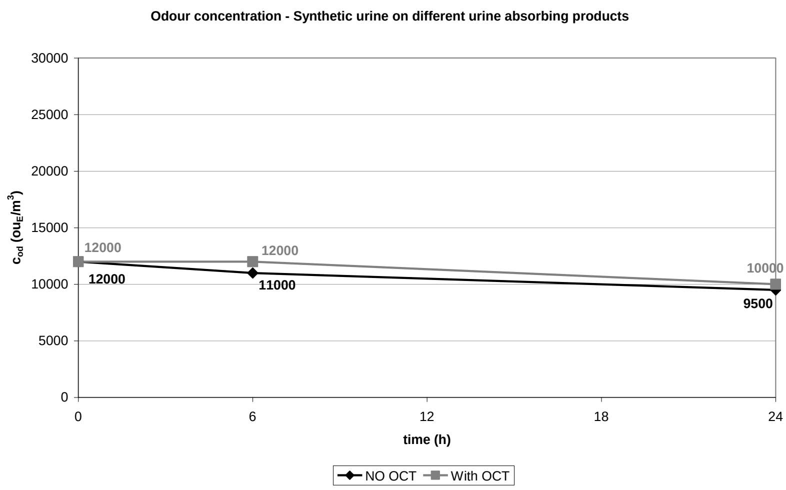

Figure 4: Odour concentration trends of adsorbing product with or without odour control technology OCT

3.2.2. Hedonic tone measurements

Hedonic tone of the headspace air in contact with the different products show significant differences, demonstrating the sensorial method effectively measures and compares the different adsorbing products. The hedonic tone measure have been performed within a time range that represents the entire life cycle of the product from wearing to disposal, including conventional average wearing time for the size of the tested products. The hedonic tone of products containing specific and effective odor control technology is closer to neutrality (zero value, representing absence of malodor) for all the time length the experiment has been run (sampling at 0, 6, 24 h). Significantly higher negative values (presence of urine malodor) are present in those products without specific odor control actives. In addition our tests show that the efficacy of the odor control actives increases with the time it is in contact with the urine. The effect of odor control is already visible after 6 h with values that gets closer to neutrality. On the contrary, the product without odor control active stays within very negative values showing no or very little efficacy in reducing the urine malodor.

Figure 4 shows the hedonic tone trend (T.E.) of synthetic urine on different absorbing products with or without odour control technology. Hedonic tone values are the arithmetical mean of 90 hedonic tone values from 15 panellists at 6 dilution steps.

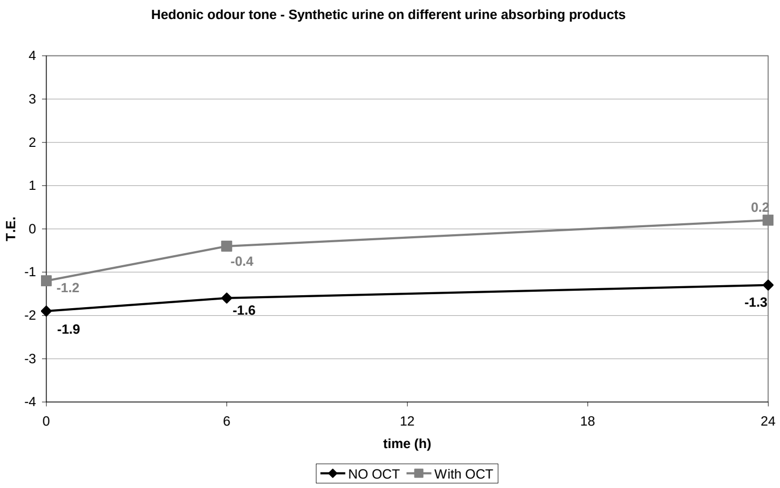

Figure 4: Hedonic odour tone trends of adsorbing product with or without Odour Control Technology

The more the dilution steps are low (the more odour concentration are high) the more the differences on hedonic tone are high. As an example Figure 5 reports the hedonic tone trend of synthetic urine on different absorbing products with or without odour control technology at 24 h versus odour concentration. Hedonic tone reported values are the geometrical mean of 15 hedonic tone values at each dilution steps.

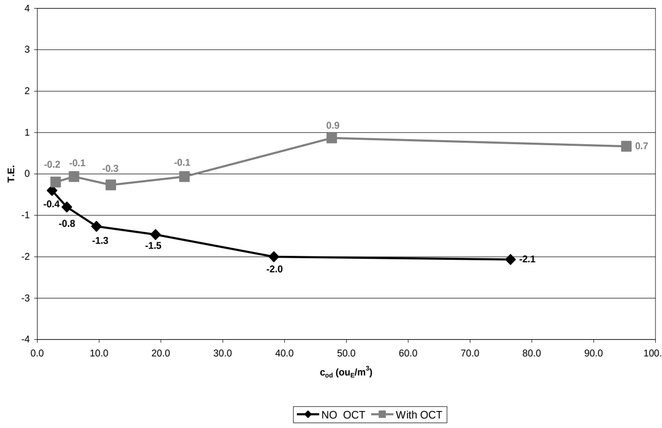

Figure 5: Hedonic odour tone after 24 hours on adsorbing product with or without Odour Control Technology

4. Conclusions

This paper describes the methodology to evaluate the efficacy of different absorbent products in reducing the urine malodor. The development of the synthetic urine, similar to the real biological urine, allows to perform repeatable and reproducible sensorial tests and allows the comparison among different products, assessing their real efficacy in the control and reduction of the urine malodor. The method is based first on the identification of an artificial urine-like fluid to be used for the sensorial tests, as to make them reproducible and free from any biological risk. Another important aspect of the described methodology is that it relies on the evaluation of the hedonic odour tone, which turned out to be the most effective parameter allowing to discriminate different absorbing product.

References

Roberts R.O., Jacobsen S.J., Reilly W.T., Pemberton J.H., Lieber M.M., Talley N.J., 1999, Prevalence of combined fecal and urinary incontinence: a community based study. J. Am. Geritr. Soc.47, 837-841.

International Standard ISO 15621:2011, 2011, Urine- absorbing aids- General guidelines on evaluation.

International Standard ISO 6658, 2005 Sensory analysis- Methodology- General guidance.

Tyan Y.-C., Yang M.-H., Liao P.-C., Liao J.-D, Jong S.-B., Liu C.-Y., Wang M.-C., Grunze M., 2007, MALDI-TOF MS sample preparation by using alkanethiolate self-assembled monolayers: a preliminary application for protein sample analysis, International J. of Mass Spectrometry, 262, 67-72.

Mills G.A., Walker V., 2001, Headspace solid-phase microextraction profiling of volatile compounds in urine: application to metabolic investigation, Journal of chromatography B, 753, 259-268.

Perring K.D., Beham M.J, Griffin S., Vela M., 2007, Malodour composition, Patent No. WO/2007/113513

CEN, 2003, EN 13725:2003, 2003, Air quality - Determination of odour concentration by dynamic olfactometry, Comité Européen de Normalisation, Brussels.

VDI 3882- Part 1, 1992- Determination of Hedonic Odour Tone, Verein Deutscher Ingenieure, Berlin, Germany.

VDI 3882- Part 2, 1994- Determination of Hedonic Odour Tone, Verein Deutscher Ingenieure, Berlin, Germany.

Zhang Q., Feddes J.J.R., Edeogu I.K., Zhou X. J., 2002, Correlation between odour intensity assessed by human assessors and odour concentration measured with olfactometers. Canadian Biosystem Engineering, 44, 6.27-6.32.